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The Ohio State University, Ph.D., 1972
Education, theory and practice

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THE TEACHING OF A COLLEGE LEVEL PHYSICAL GEOGRAPHY- 
EARTH SCIENCE COURSE BY AN AUDIO-VISUAL-TUTORIAL 
INDEPENDENT STUDY METHOD: AN EVALUATION

DISSERTATION
Presented in Partial Fulfillment of the Requirements for 
the Degree Doctor of Philosophy in the Graduate 
School of The Ohio State University

By
Edward Ellsworth Lyon, B.S. in Ed., M.S. in Ed.

* * * * * * *

The Ohio State University
1972

Approved by

Fred R. Schlessinger,
Adviser
College of Education
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VITA

December 11, 1930 . . . . . Born - Paxton, Illinois

1958 . . . . . . . . . . . . . . B.S. in Ed., Illinois State University, Normal, Illinois

1959 . . . . . . . . . . . . . . M.S. in Ed., Illinois State University, Normal, Illinois


1959-Present . . . . . . . . Geography, Geology, and Earth Science Professor, Ball State University, Muncie, Indiana

PUBLICATIONS


FIELDS OF STUDY

Major Field: Science Education. Professor Fred R. Schlessinger


Higher Education. Professor Herbert Coon
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CHAPTER I

INTRODUCTION

Rationale

In recent years there has been much concern about the effectiveness of various teaching methods and materials used in the presentation of science courses at all educational levels. Numerous new programs have been developed for use in both elementary and secondary schools. Some of the better known of these are the Elementary Science Study, Science Curriculum Improvement Study, Earth Science Curriculum Project, Introductory Physical Science, and Physical Science Study Committee Physics. These programs have attempted to upgrade the student's general education and to assist him in critical thinking.

Colleges and universities also have seen the need to provide better general education programs, including courses in the sciences. As can be seen from Table 1, a survey of several college and university catalogs shows that an important segment of a student's college work consists of general education, and this segment includes numerous science and/or mathematics courses. Of the colleges and universities surveyed, general education requirements ranged from 54 quarter hours (29.0 per cent of the total
<table>
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<td>54 hours</td>
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*Hours are quarter hours. See bibliography for sources of information for Table 1.
hours required) at West Texas State University to 90 quarter hours (46.9 per cent of the total hours required) at Glenville State College. Within the general education requirements, courses in science and/or mathematics vary from 22.0 per cent of the total at Indiana State University to 33.4 per cent at the University of Wyoming. The average amount of time spent in general education during a four year program is 71 quarter hours; the average percentage of time spent in the sciences and/or mathematics, within the general education requirement, is 25.9 per cent.

Until recently, many science courses, including those predominantly planned as part of the general education programs, were taught to relatively small groups of students. The great influx of students which followed World War II, and which has continued since that time, however, has necessitated the development of other instructional methods. These include the combination of large lecture sections with smaller laboratory groups and the use of closed-circuit television.

As a further attempt to solve this problem, various types of independent study courses have been initiated. There are, of course, other and more vital reasons that justify the use of independent study or individualized teaching-learning methods than merely the need to serve large numbers of students. Properly organized, audio-tutorial and audio-visual-tutorial instructional methods may offer advantages for cognitive growth. These, and other reasons, will be more fully discussed in Chapter Two which
reviews the literature of independent study.

Although there has been some problem in defining just what independent study is, there appears to be agreement that independent study courses embrace a number of different teaching and learning procedures in which the student assumes a degree of responsibility for completing course requirements.\(^1\) Gleason related that there were, as of 1967, few specific research results which differentiated independent study programs. Furthermore, systematic evaluation of these programs appeared to be almost totally lacking.\(^2\) Beggs and Buffie described several public school independent study programs, but did not evaluate the programs.\(^3\) Cyphert noted that "The literature is full of testimonials to successful programs but virtually void of unfavorable comments or analyses substantiated by empirical data."\(^4\) Maccini also indicated the dearth of quantitative studies of independent study programs,\(^5\) and Thompson and Dressel's survey of independent study practices reported that very little evaluation of independent study programs exists.


\(^4\)Cyphert, op. cit.

A number of institutions of higher learning are involved with teaching laboratory segments of science courses with individualized instruction methods. Postlethwait, of Purdue University, became a leader in audio-tutorial (A-T) instruction in a course in botany. Postlethwait, of Purdue University, became a leader in audio-tutorial (A-T) instruction in a course in botany.7 Richason first used the term audio-visual-tutorial (A-V-T) instruction with his development of individualized instruction for a geography course at Carroll College, in 1966.8 Beckman emphasized the challenge of A-V-T in a curriculum resources development program.9 Ehrhart and Mellander have been teaching physical geography laboratory sections with A-V-T materials since 1968 at Western Michigan University.10

Alexander and Hines provided a comprehensive report on individualized instruction programs of thirty-six secondary schools in a number of states. Here again, however, the study was predominantly descriptive, although questionnaires, letters, and


interviews provided much interesting information concerning the success of these programs. Bonthius also described individualized study programs at twenty-one universities and colleges, but did not systematically evaluate specific programs.

The few evaluative reports include those of Maccini, who completed an evaluative study of independent study in an introductory geology laboratory at The Ohio State University in 1969 and Bybee, at Colorado State College who, in 1968, evaluated an individualized approach to a general education earth science laboratory. In both cases the conclusions were favorable. Bybee, in fact, noted that students in the experimental class rated the course significantly higher than a control group. Further discussion of these studies may be found in Chapter Two.

There appears to be a need, then, for additional careful and objective research concerning independent study. This need led the investigator to complete the research for this study.

\[1^{13}Maccini, op. cit., pp. 167-177.\]
\[1^{15}Ibid.\]
General Education Physical Geography–Earth Science at Ball State University: Background

The investigator has been particularly concerned with the introductory physical geography–earth science course at Ball State University since 1963. The introductory earth science course was initiated at that time as part of the general studies program of the university. During the first year, a number of sections of thirty-six students each were taught by several instructors. Students attended three lectures of fifty minutes each and one two-hour laboratory session per week. Laboratory sessions consisted primarily of working with problems assembled in a study manual. The rapidly increasing student population, and the desire of the geography and geology staff to maintain a course wherein all students taking the course would receive similar course materials, led to the development and implementation of the first Ball State University closed-circuit television lectures for large audiences. This occurred in 1964. During the 1970-1971 academic year, approximately 900 students were enrolled in the course each quarter. Students attended two fifty-minute closed-circuit television lectures per week, one two-hour laboratory session, and worked independently with programmed instruction materials one to two hours each week. The laboratory sessions were taught by a number of undergraduate and graduate students, primarily with major or minor academic areas in geography, geology, or earth science. In the Autumn quarter, 1970, the course name was changed
to Fundamentals of Physical Geography and Earth Science, but the method of presentation remained the same.

The investigator has observed several thousands of students complete the requirements of this general education physical geography-earth science course during the past six years. During this period, he has listened to many gratifying comments concerning the closed-circuit television lecture series. He also has listened to a number of adverse comments of this teaching method. The latter comments were an added encouragement for the investigator to begin the research needed for this report.

The Problem

The problem, therefore, chosen by the investigator for this research was: What are some of the effects and results of teaching the course, Fundamentals of Physical Geography and Earth Science, to matriculating freshmen at Ball State University by a modified independent study method? In order to solve the problem, the course was modified, as will be explained below, and results, as shown by testing, were evaluated. Students were chosen by stratified random selection. Data were gathered during the Autumn quarter, 1971.

In the study of the primary problem, two sub-problems became evident which also seemed worthy of study and of inclusion in the report. These sub-problems were: 1) What kinds of questions (testing) will help to bring about changes in students' cognition, and 2) What changes in student attitudes toward science and
scientists may evolve from taking the course by the independent study method?

For the purpose of solving the first sub-problem, pre-tests and post-tests were prepared for each of the units into which the material was divided. Further, from these tests, an inclusive fifty-question test was devised for use prior to and following the completion of the entire experimental work. The total 110 questions used were analyzed, using an adaptation of Bloom and Sanders, in which questions were given a hierarchy of ranking according to the types of thinking they required. Complete descriptions of the procedures used and an analysis of the results are contained in Chapters Three and Four.

The second sub-problem necessitated the selection of a suitable attitude scale. The scale chosen was that prepared by Cummings at The Ohio State University, which included sixty-seven items about science, scientists, and scientific careers. A complete description of the scale, methods of using the scale, and its administration are included in Chapter Three. An analysis of the results is contained in Chapter Four.


The investigator also interviewed thirty randomly-selected students who completed the experimental program in order to obtain their personal views concerning the experimental teaching-learning method. The procedure used in administering the interviews is detailed in Chapter Three. The interview results are included in Chapter Four.

Hypotheses

In solving the primary problem, certain hypotheses were devised. These were, as follows:

1. No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample with the highest total Scholastic Aptitude Test (SAT) scores\(^1\) and the 27 per cent of the student sample with the lowest total SAT scores.

2. No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample with the highest percentile rank in their high school graduating class and the 27 per cent with the lowest percentile rank in their high school graduating class.

3. No statistically significant differences will exist between the mean gain of achievement scores attained by those who declared a major academic preparation area upon matriculation and those who did not declare a major academic preparation area upon matriculation.

4. No statistically significant differences will exist between the mean gain of achievement scores attained

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\(^1\)Educational Testing Service, *A Description of the College Board Scholastic Aptitude Test, 1971-1972* (Princeton, N.J.: Educational Testing Service, 1971), pp. 5-6. SAT scores are scores obtained from standardized tests taken by most juniors or seniors in secondary schools in the United States; designed primarily for college admissions evaluation, these tests measure verbal and quantitative achievement.
by the 27 per cent of the student sample which spends the greatest amount of time using the study carrels and the 27 per cent which spends the least amount of time using the study carrels.

5. No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample which spends the greatest number of times using the study carrels and the 27 per cent which spends the least number of times using the study carrels.

6. No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample with the greatest gain in positive attitude toward science and the scientist and the 27 per cent with the least positive attitude gain toward science and the scientist.

The hypotheses were tested by using a pairwise-related t test to determine if the students learned the material significantly by taking the modified physical geography-earth science course, and by using an independent t test to determine if the students learned the material differentially at significant levels. Further explanation of the use of the t tests may be found in Chapter Three. An analysis of t test results is contained in Chapter Four.

Definition of Terms

Independent Study - Study within a structured course, with minimal formal supervision by an instructor, and including the use of audio-taped lectures, integrated laboratory investigations, and other activities within the confines of a study carrel or its immediate vicinity.

Study Carrel - A small area, booth, or cubicle in which the
students may complete the requirements of the modified physical geography-earth science course. Each carrel was outfitted with an audio-tape cassette player, a headset, a slide projector, and study materials needed for each assignment. The study carrel room also contained laboratory study tables, a supervisor's desk, and cabinets for housing equipment.

Assumptions

For purposes of this study, the investigator made the following assumptions:

1. Students would respond honestly to tests and questionnaires.

2. External sources would not prejudice students in any specific way before they responded to tests and questionnaires.

3. Graduate student assistants would work with students in a manner prescribed by the investigator.

4. Equipment malfunction would not disrupt course performance by students.

5. Students would cooperate with the instructor to the best of their ability when working with the several segments of the course.

6. The modified physical geography-earth science independent study course would change student attitudes toward science and the scientist, and any change would be the result of taking the course.
7. The J.R. Cummings attitude scale is a valid instrument.
8. The instructional content of the course would be adequate in covering the several segments of the modified physical geography-earth science independent study course.

**Delimitations of the Study**

For the purposes of this research, the following delimitations were made to the study:

1. The study was confined to a stratified random sample of 110 matriculating students, taken from the much larger total student enrollment of matriculates at Ball State University. An attempt was made to select a sample representative of the total group from the standpoint of percentage of distinguished students, regularly-enrolled students, and students admitted with warning.

2. Some student attrition was expected. Of the initial 110 students enrolled, 100 students completed the course requirements.

3. The personnel working with the students in the carrel study area included the investigator and five graduate assistants. There were no personnel changes during the period of the research.

4. The matriculating students were all first-quarter freshmen.
Limitations of the Study

For purposes of this research, the following limitations were made to the study:

1. Since only five study carrels were available, use of the study carrels was initially limited to two, one-hour sessions per week.

2. Course content was limited by the necessity of scheduling students to two attendance sessions per week.

3. The total number of students included in the student sample was limited by the available physical facilities.

Preliminary Procedures

Although this research study was conducted during the Autumn quarter, 1971, preliminary preparations were conducted during the Winter and Spring quarters of the academic year 1970-1971, and the summer of 1971.

Preliminary procedures were:

1. preparation of the physical facility.

2. acquiring the needed equipment.

3. preparation of the first, second, and final drafts of the tape cassette lectures.

4. preparation of needed laboratory materials.

5. preparation of the slides needed for the lectures.

6. preparation of the charts and models needed for lectures and laboratory investigations.

7. preparation of necessary pre-tests and post-tests.
8. preparation of lectures, audio-tapes, and tests in a format to be used by a pilot class.

9. preliminary use of the materials with a group of twenty-seven students.

10. student evaluation of the preliminary program.

11. final refining of tape-cassette lectures, tests, and other materials following student evaluation of the preliminary program.

Procedures

Although the selection of the student sample used in the study, the materials used, and the procedures followed in completing the research are all more fully discussed in later chapters, a brief synopsis of these factors is provided here in order that the reader may more fully understand the overall attack on the problem.

The student sample participating in the study was enrolled during the summer of 1971 with the help of the university Office of Curricular Advising. The initial enrollment of 110 students was accomplished on the basis of three criteria: 1) all enrollees in the experimental class would be freshman matriculates, 2) students admitted to the university with distinction, those enrolled on a regular basis, and those admitted with warning would be enrolled in the experimental class in approximately the same proportions as they were included in the total population of freshman matriculates, and 3) within the framework of the first
two criteria, the enrollees in the experimental class would be randomly selected.

During the first class meeting, the participating students were provided orientation in the teaching method and use of the equipment. The science-scientist attitude scale was administered during the second meeting, and the fifty-question comprehensive pre-test at the third meeting. The routine of using the study carrel course materials two hours each week began with the fourth meeting. The usual routine for the student using a study carrel included: 1) taking a pre-test on the content material of the current unit, 2) listening to short audio-taped lectures, 3) completion of the necessary activities and investigations, and 4) taking a post-test on the content material. Following completion of all units, the student was given the post-attitude scale and the fifty-question comprehensive test again. Careful records were kept of student achievement and of the use of the study carrels. In addition to completing the other course requirements, thirty students were randomly selected and asked to provide subjective opinions concerning the program. This was accomplished in complete privacy through the use of taped interviews.

Summary

Colleges and universities have seen the need to provide better general education programs, including courses in the sciences. Until recently, many of these science courses were taught to relatively small groups of students. The great influx of stu-
dents since World War II, however, necessitated the development of other instructional methods. Large lecture sections with smaller laboratory groups was one method of instruction that became popular, as well as the use of closed-circuit television to teach large numbers of students. Various types of independent study courses also were initiated as a means of serving large groups of students. The use of audio-tutorial and audio-visual-tutorial teaching-learning methods became a means of not only serving large numbers of students, but showed promise of being an effective method of teaching and learning.

Although there has been little evaluative research on independent study, a number of colleges and universities have initiated audio-tutorial and audio-visual-tutorial programs for use with laboratory segments of science courses.

Evaluative research in this area has begun, however. Maccini, at The Ohio State University, and Bybee, at Colorado State University, for example, have completed research reports concerning their work with geology and earth science laboratories, respectively.

For this research, the problem was: What are some of the effects and results of teaching the course, Fundamentals of Physical Geography and Earth Science, to matriculating freshmen at Ball State University by a modified independent study method? In order to solve the problem, the course was modified, was implemented during the Autumn quarter, 1971, data were
gathered, and the results, as shown by testing, were evaluated.

Chapter Two contains a review of the literature of independent study considered relevant to this research. The chapter will present six topics, as follows:

1. Perspective on independent study.
2. Definition of independent study.
3. Independent study, a traditional view.
4. Audio-tutorial and audio-visual-tutorial approaches to independent study.
5. Evaluative research concerning A-V-T approaches to independent study.
6. Guidelines for this research resulting from the review of the literature.
CHAPTER II

A REVIEW OF THE LITERATURE OF INDEPENDENT STUDY

Introduction

Upon examination of the literature of independent study, three basic facts immediately become apparent:

1. There is a problem of definition. Different writers have not always agreed upon the total meaning of the term independent study, or exactly what methods of instruction should be included within it.

2. Two major instructional methods are, however, found in the literature and are most prevalent in higher education today. They are: a) individualized instruction on an approximate one-to-one teacher-student basis, and b) audio-tutorial and audio-visual-tutorial teaching-learning.

3. Evaluative research concerning independent study is extremely limited.

In spite of the problems mentioned above, six topics were discussed in this chapter on the literature of independent study. These were:

1. perspective on independent study.

2. definition of independent study.
3. independent study, a traditional view.

4. audio-tutorial and audio-visual-tutorial approaches to independent study.

5. evaluative research concerning A-V-T approaches to independent study.

6. guidelines for this research resulting from the review of the literature.

Perspective on Independent Study

Gagne. As one reads of the independent or individualized study programs being implemented in the United States, there may be a tendency to believe that independent study is a recent innovation. In reality, independent study, in some form, has been with us for some time. Gagne reported that concern for the individual student has been one of the primary threads of emphasis running through American educational history. Further, there has been an associated tendency to place considerable responsibility upon the student for his own intellectual development. Abraham Lincoln was greatly admired for educating himself. Even in the one-room schoolhouse, the individual student, under the guidance of the teacher, learned largely in an individual manner. The apt and eager student could and did learn much; the less apt would learn much less in the given amount of time.²⁰

Gagne further reported that in the early 1900s, Dewey brought forth the idea that what the individual child needs to learn is whatever he has not already learned, and that which fills his needs and contributes to the meeting of his life goals. This suggestion by Dewey has been interpreted by many to mean individual responsibility for learning.\textsuperscript{21}

Boenthal. Bonthius, and others, related that the history of independent study in the United States could very well have begun in Colonial times. It was early a substitute for collegiate education, and was certainly utilized in apprenticeship training for the professions.\textsuperscript{22}

There also were early influences leading to the individualizing of undergraduate education in colleges. One of these was the desire of many colleges and universities for professors to apply the methods being used "successfully" with graduate students, to undergraduates. Another influence was the desire to allow the student more freedom in the selection of courses. At Harvard, an elective system was introduced in 1869. This program, while not altering the methods of teaching, did increase the opportunity for the student to determine the content of his educational program. This change from standardization of curricular requirements soon spread throughout most American colleges.\textsuperscript{23}

\textsuperscript{21}Ibid., pp. 15-16.
\textsuperscript{22}Bonthius, op. cit., p. 10.
\textsuperscript{23}Ibid., pp. 10-11.
At Harvard, however, other ideas soon prevailed and student choice of electives became gradually more restricted. In 1909, the more-or-less free elective system was replaced by the concentration-distribution system. This system was one in which the student elected courses within disciplinary areas, but was required to take courses in a certain number of fields.

In 1912, broad-learning comprehensive examinations were added at Harvard. These examinations almost immediately brought a new factor of independent study into play. In order that the student perform on the examinations with maximum effectiveness, a tutorial system was introduced. Professors generally agreed that the average student would not be able to pass the examinations without the individual guidance of highly-trained scholars, namely, the professors themselves, who created the policies under which the comprehensive examinations would be given. From the Harvard tutorial system, then, came independent study on a one-to-one basis, a teacher-student relationship.\(^{24}\) Brown. It should be noted here that, as Brown emphasized, from the very beginning of organized education, educators have presented a united front against the thought that a student can learn as much, and perhaps a great deal more, if allowed to learn on his own initiative rather than as a captive audience in the traditional classroom. The idea of independence in learning, in fact, has been considered in such a mystical light, that only the

\(^{24}\)Ibid., p. 11.
very mature student at the highest level of learning, i.e., the graduate student, has been considered capable of successfully using this approach.\textsuperscript{25}

Independent study, therefore, has been slow to make its way down from graduate to undergraduate education, so slow that "if the process were compared to the progress of a snail, the latter would appear to be a speed demon."\textsuperscript{26}

As noted above, most of the independent study programs that were implemented before 1920 were part of required programs for all students. Following 1920, however, their use in required programs became almost non-existent. Since that time, independent study at the college level has instead become the exclusive privilege of the able student.\textsuperscript{27}

Brown suggested that independent study of the one-to-one, teacher-student relationship type should never be required. In his opinion, the very nature of independent learning made it a voluntary activity. He reported that the only institution which has been able to handle independent study on a required basis is Oxford, a school which has a highly organized style of independent learning.

The Oxford model has been the one from which numerous Amer-


\textsuperscript{26}\textit{Ibid.}, p. 20.

\textsuperscript{27}\textit{Ibid.}, pp. 24-27.
ican colleges and universities have initiated independent study programs. Even today, the Oxford program is the most intensely individualized prototype ever developed. Credits and hours are not part of the program, and no courses are required. The Bachelor of Arts degree is awarded on the basis of the results of a number of examinations and a minimum term of residence. Each student is assigned to a tutor shortly after enrolling at Oxford. The tutor guides the student through a series of readings and other assignments throughout his college career. The student reports to his tutor on a regular basis to discuss his work. The tutor is the expert, but encourages the student to complete his work independently.

As the Oxford tutorial "spun-off" into American higher education, the regrettable result was that most independent study courses became highly restrictive, apparently because of professorial influences. Students haven't been allowed the kind of intellectual freedom which they need if they are to learn to work independently.  

Wirth. As was stated by Wirth, at first glance one might defend the use of independent study methods purely from the standpoint that there are 50,000,000 Americans who want or need education beyond the secondary level. It may be that it is desirable to release some students from the classroom to "go it on their own" for that reason. As he went on to state, however, there are  

\[28\] *bid.*, p. 27.
surely other healthier impulses behind the trend toward independent study. The move to independent study should represent a salutary response to a basic need, the need of the human being to experience himself as an end, rather than as a mere function of the "System," a dehumanized number.  

Care must be taken in utilizing independent study from the sole standpoint of "going it alone." Surely, attention must be paid to the individual, to his needs, within the framework of independent study. Even though an individual may feel the need for the value of individuality (i.e., independent study), he also feels the polar value of the need for community. On the side of individuality are values like challenge, criticism, creativity, and innovation. On the side of community are solidarity, social support, order, and tradition. If one value is given exaggerated attention to the neglect of the other, the results are less than desirable. It has been suggested that stress on values related to individuality can lead to self-indulgence, callousness, anarchy, and disruption of norms. An overconcern with the social, on the other hand, can produce conformity, manipulation, repressive control, stagnation, and the arrogance of unchecked authority. There is no fixed or final formula which establishes a satisfactory relationship. New circumstances, in fact, crop up continually which disturb the balance between individuality and

community. From an education standpoint, Wirth suggested that the skilled teacher, by analogy, realizes the importance of "knowing when to give students their heads and when to tighten the reins." He also warned that the aggravation of the skirmish between the polar values of individuality and community in the free society at large is a part of decision-making in school instruction. Effective learning requires a concern for the contributions implicit in both sets of polar values for:

on the side of individuality we had better be concerned with teaching strategies that provide chances for the student to create order and meaning for himself, that let him wrestle with questions which stir him, that enable him to tap resources within himself as a whole person. But in warming to the praises of such behavior, it is too easy to engage in ridicule of organized studies. If we ignore the constructive aspects of subject matter, we merely prepare the way for another lurch around the bend just ahead. We should know now that the systems of knowledge contain indispensible values. They represent the long and arduous efforts of the human mind to build order, clarity, and understanding. They contain the conceptual insights upon which efforts to gain greater control must be based. The methods of thought used to win them are rooted in standards of craftsmanship, scholarship, and discipline. Uncritical zeal for independence and free expression can lead to special kinds of wastelands. We have been there, too.

All of this seems embarrassingly obvious and should go unmentioned if history did not remind us how easily we forget the complexities that are involved in responsible freedom. The great error is the yearning for the neat and simple formula. The reach for certainty was the original sin, and it is still the great betrayer.

Some honest pessimists believe that American society is

30 Ibid.
31 Ibid.
so gripped by the "System" that it is incapable of human response. If this is true, talk of independent study is just that. If we do not subscribe to this negative view, we must attempt to attend to the health-giving impulses inside human beings. The possibilities of experimenting with independent study, the availability of technological advances—the hardware of independent study, and understanding that independent study for its own sake is not enough, provide the framework within which educators can cultivate youth "capable of initiative and responsibility, equipped with skills of inquiring for themselves into the meaning of this fantastic world, and above all, capable of becoming persons who respect themselves as ends to be cultivated, and who because of that want nothing less for others."32

Postlethwait. Postlethwait stated that were it possible to reexamine the activity called education and start again at point zero, a fundamental guideline to be given prime consideration, in the new beginning, would be that "learning is an activity done by an individual and not something done to an individual."33 The educational system would be structured so that the program, by necessity, would involve the learner. The teacher's position would be to create a situation wherein the individual student is given direction and motivation to learn. The program would therefore allow for individual differences in interests, capa-

32 Ibid.

33 Postlethwait, 1969, op. cit., p. 1. Underlined words are italicized in the text.
city, and background. In this system, one of the most important roles of the teacher would be guidance. No longer would the teacher waste time trying to camouflage the topics which are likely to make good test questions. No longer would the student be striving to discover the mannerisms by which the teacher may disclose the questions. 34

Torrance. Another extremely important reason for considering the use of independent study is the growing realization that one of the significant concerns of education is to give the student the motivation and skill for lifelong learning. Education does not (or at least, should not) stop upon graduation from high school. Much of the graduate's continued learning is likely to be through independent study in one form or another. Such study, then, should be practiced and encouraged from an early age.

It has been further suggested that use of independent study has in some instances solved certain teaching problems. Some examples cited by Torrance were:

1. Severe behavior problems have disappeared when children have been allowed to study independently.
2. Nonreaders have become readers.
3. Nonachievers have become outstanding achievers.
4. Social isolates and rejectees have become accepted, productive group members.
5. Apathetic, reluctant learners have become eager and

34 Ibid., pp. 1-2.
excited about learning.

These incidents occurred more or less accidentally, not during controlled, active evaluative research. Independent study, though, should not be considered a panacea for all educational ills. Some students require a great deal of structuring in their learning. Some may waste the time allotted for independent study.35

Definition of Independent Study

As previously stated, there has been some problem in defining just what independent study is. The literature of independent study reveals two kinds of definitions. These may be classified as a historic definition, and as a more modern, technologically-oriented definition. These definitions, in themselves, however, do not appear to entirely identify independent study.

Bonthius. Bonthius, and others, provided what might be considered a historic definition, although it remains suitable for some independent study programs, today. This definition stated that: "independent study is the pursuit of special topics or projects by individual students under the guidance of faculty advisers apart from organized courses."36 This definition, then, includes

36Bonthius, op. cit., p. 8.
two major characteristics: 1) faculty supervision and 2) a high degree of freedom on the part of the student in selecting a topic for study and developing it. These characteristics relate to the earlier "honors" courses which prevailed in the 1920s, although the term "honors" did not, in itself, differentiate types of instruction that had been developing over the years. The Harvard tutorial system was a case in point in the utilization of the above definition, that is, the use of independent study on a one-to-one basis, a very personal relationship between student and teacher.

Postlethwait. The more modern and technologically-oriented definition is basically related to the use of modern multimedia communications systems in serving the educational needs of large numbers of students. An examination of the literature of audio-tutorial and audio-visual-tutorial instruction informs the reader that recent technological advances now permit educators to create a much greater variety of learning experiences. The use of facilities and equipment such as study carrels equipped with tape players, headsets, slide projectors, charts, models, and related teaching-learning materials provides a setting wherein a student may learn individually, informally, and at his own pace, while, at the same time, he is working under the "personal" direction of a teacher (the voice on the audio-tape).38

37 Ibid., p. 6.
Richason, et al. Richason, Beckman, and others, and Ehrhart and Mellander have described audio-tutorial and audio-visual-tutorial programs in which the inference is that these kinds of programs provide for the individual needs of students of different abilities, interests, and backgrounds. Denton suggested that the student, through his own efforts, and not those of the group, should determine his own learning rate and individual progress.

The Investigator. For the purpose of this research, the thoughts of these authorities were combined to lead to a definition of independent study as: study within a structured course, with minimal formal supervision by an instructor, and including the use of audio-taped lectures, integrated laboratory investigations and other activities within the confines of a study carrel or its immediate vicinity.

This definition differs from the historical definition in several respects. These are:

1. The definition does not limit independent study to a one-to-one, teacher-student relationship. Many students may be served by one or several instructors.

2. The independent study is completed within a structured

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39 Richason, op. cit.
40 Beckman, op. cit.
41 Ehrhart and Mellander, op. cit.
3. The independent study utilizes the advantages of modern technological advances in multimedia communications systems.

The definition, however, retains the "flavor" of the more historical definition in that:

1. The individual student is still the important "cog" in the educational process.

2. The instructor is available to the student (in the case of this research study, both on audio-tapes and in person, as needed).

Cyphert. Independent study is not only difficult to define (each individual situation may require its own definition), but it is also apparently a term that has been used as a "catch-all" for describing any number of teaching-learning situations. Cyphert has asked a number of questions that may not be completely or satisfactorily answered for some time. For example:

1. Can independent study be both a panacea and a fraud?

2. What is independent study?

3. What are the objectives of independent study?

4. Can the objectives of independent study be attained?

5. What kinds of students can be successfully involved in independent study?

6. What kinds of content are amenable to independent study teaching-learning methods?
Cyphert also inferred that independent study may be a "two-headed monster." On the one hand, the individual has the responsibility for his own continuing education. This has been identified by many as the ultimate goal for American education. Learning does change behavior and these changes are necessarily personal, and therefore individualistic. Self-pacing, self-discovery, and self-dependence are all central to individual learning. Independent study provides an approach wherein the student may himself determine the relevant, execute his own learning, and evaluate his own progress.

On the other hand, critics suggest that resorting to the use of independent study is an admission that educators do not know how to teach and that these programs are merely devices functioning to relieve teachers of the obligation of paying attention to students. Independent learning appeals only to the highly intelligent, those intensely motivated or academically inclined.43

Such divergent opinions help to explain why, then, there is little wonder that there have been problems in defining independent study.

Independent Study--A Traditional View

Bonthius. Although the decade of implementation of independent study programs in American colleges and universities was between 1920 and 1930, when more than seventy-five institutions adopted

some form of individualized instruction, several independent study programs began in the last century. St. Vincent College, in Pennsylvania, for example, required independent study of its students from 1870 to 1948, at which time students could instead elect a comprehensive examination as an option. The University of Illinois required a thesis for the Bachelor's degree, from its founding in 1871, until 1895, when the thesis requirement was continued only for students electing the Specialized Course system. Bates College, in 1907, began requiring independent study for credit, Guilford College, in 1910. Princeton University began a preceptorial system in 1905, wherein small groups of students completed work for credit under the leadership of a preceptor. Reed College has had an independent study program since its founding in 1911, Rice Institute since 1913, and Lafayette College since 1917. Harvard's tutorial program began in 1912. Independent study programs have thus been utilized in this country for about one-hundred years, in one form or another.

The amount of credit given for independent study has been an important consideration since the inception of this type of program. The majority of these programs have given some academic credit which counts toward graduation. Bonthius listed three ways in which credit has been given:

44 Bonthius, op. cit., p. 12.
45 Ibid., p. 11.
1. Independent study is treated as a course in itself, wherein the content material is determined by the student, with the specified number of credits and the grade being recorded as in any ordinary course.

2. The independent study program more or less parallels a regular course.

3. The independent study students are separated completely from regular courses and receive credit solely on the basis of their independent work.

The earlier surveys completed on the scope of independent study were based on sampling methods. The National Research Council, in 1925, made the first survey of this type, under the direction of Frank Aydelotte, then president of Swarthmore College. The Council sought information from an unspecified number of higher education institutions which listed "honors" programs in their catalogs. Seventy-five schools announced that they provided independent study only for "honors" students. Eighteen institutions described independent study programs in which juniors and seniors could, on a voluntary basis, take a part, or even all of their last two years in this type of program. This study did not disclose any required types of independent study programs.46

Mary B. Taylor, in 1930, completed a Master's thesis at Occidental College in which she reported the results of a ques-

46 Ibid., pp. 18-19, 21.
tionnaire she sent to the 227 colleges then on the approved list of the American Association of Universities. Her results indicated eighty-three colleges were providing "honors" programs.

In 1932, Kathryn McHale reported one-hundred colleges were providing independent study programs. In 1934, Aydelotte again reported on the use of independent study programs. This survey revealed that 130 of the 200 institutions then approved by the American Association of Universities were offering independent study programs.

Bonthius completed an extensive survey of independent study programs in the higher education institutions of the United States, reporting the results in 1957. This study was based upon an analysis of the catalogs of 1,086 of the 1,093 four-year colleges and universities in the United States which granted Bachelor's degrees. Seven schools were not included in the study because their catalogs could not be found. Of the total institutions reporting, 286 (26.3 per cent) schools reported some type of independent study plan. Furthermore, of these schools, 243 reported one plan, forty reported two plans, two reported three plans, and one institution reported five plans of independent study.47

In order to provide an accurate picture of the current independent study scene, and based upon the time and money available for their study, the Bonthius group selected twenty

47Ibid., pp. 22-23.
colleges from the larger number for further study. These were schools known to have some type of independent study program. In addition, the dearth of information about independent study to be found in college and university catalogs had considerable influence in the selection of the twenty programs. The selected group of colleges was proportionately representative of 191 required and voluntary-for-credit independent study programs in the United States with regard to institutional size, type of student body, and type of reporting.

It was found that more than one-half of the independent study programs reported by the twenty colleges in the study required the writing of papers based on library research as the primary emphasis. The second-most frequently reported activity was information-gathering and analyses based upon laboratory or field work. In third rank was artistic creation or performance. In most cases, these projects culminated in papers, field examinations or comprehensive examinations. Wooster College, for example, required all students to write papers and take comprehensive and field examinations. The Antioch College independent study program was unique in that it required the student to write a paper in which he evaluated himself—his goals, his progress, and his shortcomings. The other nineteen programs emphasized subject-matter material.

Students participating in the programs were given a great deal of freedom in choosing their topics for study. They were
required to satisfy their advisers, of course, and for the most part the projects were closely supervised. The use of individual conferences was common, especially in conjunction with the preparation of papers.48

The participating students and faculty were asked to respond to a number of questions concerning values and weaknesses of their independent study programs. Both students and faculty, for the most part, expressed similar views concerning their respective programs. The greatest exception to this was that many students objected that a number of factors were beyond the student’s control. Very few faculty members considered this a weakness of the programs.

Overall, the study reported the following strengths or values in the independent study programs surveyed:

1. the development of the ability to work independently, resourcefully, and creatively on one’s own.
2. the opportunity to probe intensively into an area of special interest.
3. the opportunity to learn research techniques.
4. the development of the ability to organize and present material.
5. the chance to receive specific preparation for graduate study.
6. the opportunity to read material supplementing courses in

48 Ibid., pp. 212-213.
the major field.
7. the opportunity for closer contact between student and the adviser.

The investigators further reported the interesting fact that "practically every claim that has ever been made for independent study received support from a few of the several hundred participants in this study."\textsuperscript{49}

The drawbacks most frequently mentioned by the participants were:

1. lack of sufficient guidance.
2. the possibilities for procrastination.
3. the feeling that the program was not so demanding or rewarding as course work.
4. the insufficient amount of time or credit allowed for the program.
5. limited library and laboratory facilities.
6. loss of valuable regular courses.
7. some students not benefitting from independent study.
8. the heavy demands on the adviser's time and energy.\textsuperscript{50}

The descriptive research results of the Bonthius group were both valuable and significant because the study appeared to bring together the literature of independent study to that time. The study, furthermore, apparently adequately described what inde-

\textsuperscript{49}\textit{Ibid.}, p. 214.

\textsuperscript{50}\textit{Ibid.}
dependent study programs of that time were like, who was involved, what the programs required, and what results might be expected from independent study carried on in a one-to-one, teacher-student relationship.

Audio-Tutorial and Audio-Visual-Tutorial Approaches to Independent Study

As previously mentioned, the great influx of students into colleges and universities following World War II, and continuing since that time, necessitated the development of instructional methods other than the traditional, small-group, class situation. Denton. An examination of the literature of independent study reveals that effective teaching of this great number of students may be accomplished by bringing into play the technological innovations of modern, multimedia communications systems. Audio-tutorial (A-T) and audio-visual-tutorial (A-V-T) teaching-learning systems may be developed as effective teaching-learning devices.

It has been suggested that A-T instruction in science may offer advantages for cognitive growth. Specifically, Denton outlined three areas in which A-T instruction may enhance individualized instruction. These were:

1. Repetition - In the solving of problems, comprehension comes as a result of repeating the material a number of times. The number of repetitions required, however, varies
with the individual. By using audio-tapes, the student may review the learning materials as many times as he believes necessary.

2. **Concentration** - The isolation afforded by placing the A-T equipment in a study carrel allows the student to concentrate on the material before him and not be distracted by outside influences.

3. **Use of Multimedia** - The use of varied approaches and materials tends to personally involve the student in learning the material.  

Postlethwait. Denton was echoing the earlier-listed advantages of Postlethwait, who discussed other advantages, as well. Among these were:

1. **Association** - The A-T study carrel facility introduces the possibility that experimental and other materials may be studied first-hand, while, at the same time providing commentary by the instructor. This eliminates the inefficiency and ineffectiveness sometimes encountered when a lecture is heard one day and the laboratory assignment com-

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pleted three or four days later.

2. **Appropriate Size of Subject-Matter Units** - The A-T approach allows the student to adjust the size of assignments to his capacity to grasp and assimilate information.

3. **Use of Multimedia** - People respond differently to different kinds of communications media. Some individuals learn best through reading, others through listening. Still others learn best by actually handling the learning materials, working with them first-hand. The A-T system can provide the student with assignments using a variety of communications media and, therefore, can best utilize his potentialities.\(^\text{52}\)

Gleason. There is no doubt but that modern technology has had a great impact on our society and culture. Whether one considers the starting point of technology from the invention of the wheel, the printing press, the steam engine, or the computer, technology has been and will continue to be a very significant thread of society and, as such, should be made a part of the educational process. Gleason, in 1967, emphasized these points and stated that the educational profession has the right and, indeed, the responsi-  

\(^{52}\)Postlethwait, 1970, *op. cit.*, pp. 31-33.
bility of assessing the implications and applications of educational technology. He further emphasized that technology, specifically in independent study situations, can perform the functions of broadcast and amplification, information storage and retrieval, control of the learning setting, reproduction to standard, and systematic organization of content.\textsuperscript{53}

Postlethwait. A number of institutions have initiated A-T and A-V-T independent study programs, in one form or another. Postlethwait, of Purdue University, however, must be considered the pioneer in audio-tutorial instruction. He first introduced this teaching-learning method in a botany course, in 1961. At that time, he prepared supplementary lectures on audio-tapes in an attempt to provide students with poor backgrounds an opportunity to keep up with the regular class. The lectures were made available through the facilities of the Audio Visual Department. Students could listen to the lecture materials at their convenience since the facility was open for their use from 7:30 A.M. to 11:30 P.M. on weekdays and from Noon to 11:30 P.M. on Sundays.

Although the initial tapes were purely supplemental lectures, the nature of the tape lectures changed as the school term progressed. This change led to audio-programming of a variety of learning experiences. In the beginning, the only materials available for use with the tapes were diagrams and

\textsuperscript{53}Gleason, \textit{op. cit.}, pp. 67-69.
photographs. The student was asked to examine various parts of the diagrams and photographs while he listened to a discussion about them. He also was asked to open his textbook and follow the text explanation while listening to the instructor on the tape. As the course progressed, the teaching-learning materials began to include living plants and, ultimately, the student was completing experiments using a laboratory manual prepared especially for the course. The students were enthusiastic about this approach to the botany course, to the extent, therefore, that it was decided to initiate an experimental section for the following semester in which thirty-six students in the program would receive all instruction programmed by audio-tape. This experimental section met with an instructor once a week for the purpose of taking quizzes and discussing the material. The students took the same tests that were given to a conventionally-taught group. At the end of the semester, the experimental group did as well as the conventionally-taught group, although no better.

As a result of the favorable testing results, and consultation with the students from the experimental class as to how the experimental program could be improved, the course in freshman botany at Purdue was completely restructured to provide "a maximum of student freedom for independent study and an opportunity for him to make adjustments for his interests, background, and capacity."\(^\text{54}\) In the restructured course, four study sessions

were developed:

1. an independent study session.
2. a general assembly session.
3. a small assembly session.
4. other activities.

The independent study session took place in a learning center, at the student's convenience. The learning center was equipped with study carrels for individual study and a central table for bulky materials. The basic equipment components in each study carrel were a tape player, an 8-mm movie projector, and other materials appropriate for the week's use.

As he began his study, the student was given a list of behavioral objectives for the week's work. His teacher was the voice of the senior professor on the tape, which led him through a variety of learning experiences. These experiences included the completion of experiments, collecting of data from demonstration materials, reading portions of the laboratory manual, and other activities deemed appropriate for the given lecture unit. When the student completed his independent study assignment for the week, he was free to leave.

The general assembly session, scheduled near the end of a week's work, was a large-group activity wherein guest lecturers were presented, long films were shown, and major examinations were given.

The function of the small assembly session (now called the
integrated quiz session) was to structure the student's approach to study. Groups of eight students participated with an instructor in discussing the week's work. All students were involved in these discussions and were expected to participate in "teaching" the others sometime during the forty-five minute period.55

Other activities in the Purdue program included the completion of one or two miniature research projects. A student who hoped to receive an "A" grade was required to complete two projects.56

Postlethwait has thus provided the newcomer to A-T or A-V-T instruction with a valuable basic reference. Richason. Richason introduced the term audio-visual-tutorial (A-V-T) to the literature of independent study when he described a new method of instruction which he introduced at Carroll College in a geography course, in 1966.

This system was similar to that pioneered by Postlethwait. It utilized a series of ten independent study booths, each equipped with an audio-tape player and a 35-mm slide projector. Two walls in each booth were constructed of heavy duty pegboard on which maps, charts, and instructions could be displayed. Several demonstration tables were located in the A-V-T laboratory to be used for displays and materials too large for use in the booths. Pictures of the independent study facility also were

55 Ibid., pp. 10-14.
56 Ibid., pp. 15-16.
included in this report.

The course work was completed in three segments:

1. The major lecture and laboratory work were completed in the study booths by means of taped discussions and colored slides.

2. The instructor met with small sections of the class once each week for the purpose of discussion, expansion of ideas, and to answer questions.

3. Each Monday a major, in-depth examination was administered to the class.

This independent study program accommodated about 160 students in 1967. The students were encouraged to use the ten-booth facility at their convenience, between the hours of 8 A.M. and 10 P.M. daily, except Sunday.

Although this report mentioned no evaluative research concerning the success of the A-V-T program, the examination grade distribution for the first semester of operation was found to be about 16 per cent higher than the average of the previous ten years under the conventional method of instruction. It also was found that students scoring below a "C" grade on examinations spent only one-half as much time using the A-V-T facility as those who scored higher on the examinations. Student reaction to this A-V-T approach seemingly indicated that it was an exciting way to learn geography.57

Beckman. Beckman has been working with A-T materials in a curriculum resources development program at Wisconsin State University, Eau Claire. The purpose of this program was to provide a wide range of materials and procedures for teaching introductory geography. These materials were to provide a variety of experiences in which the participating student would acquire a finer appreciation of spatial relationships and processes, which are primary concerns of geography. The audio-tutorial system, as pioneered by Postlethwait, was to be the instructional core of the program.

The compatibility of geography and independent study, especially when considered from the standpoint of A-T and A-V-T approaches, was emphasized in this report. Visual aids, especially maps, have been used as research tools and as instructional media in geography more than in most other disciplines. The basic concepts of geography, including areal differences, patterns of distribution, and regional interaction readily lend themselves to visualization, and thus A-T and A-V-T approaches.

The basic approach followed in this program was briefly described. Initially, an inventory would be made of the significant concepts, principles, and facts usually included in the context of basic physical geography. Textbooks, laboratory manuals, reference materials, visits to colleges of various kinds, conferences with teachers, and discussions with consultants would be utilized in the preparation of the inventory. Further,
when the inventory was completed, internal sequences, that is, order of the ideas necessary to the best understanding of the subject matter, would be established.

As subject units were completed, preliminary classroom tests would be conducted and the results evaluated. As the program developed, some time would be spent discussing and developing broad procedures. These procedures included:

1. shorter lecture periods, such as 25 minutes, which would permit fewer concepts to be presented at one time and permit greater absorption by students.

2. philosophy of group dynamics and related procedures (what should happen in a discussion section).

3. grading and evaluation procedures with test and control groups to check the results.

4. critical appraisal of field trip procedures with the opportunity to develop new techniques.

5. procedures for other broad segments as they were discovered.58

This reference provided the reader with some of the techniques that may be used in preparing, implementing, and evaluating this type of independent study program.

Ehrhart and Mellander. Two other reports outlined independent study programs in which A-V-T teaching-learning methods provided the instructional core. One of these reports discussed the A-V-T

58Beckman, op. cit., pp. 241-244.
approach used at Western Michigan University for teaching laboratories in physical geography. This program began as a pilot study during the fall of 1966. The program became operational one year later. Several steps were involved in the pilot study:

1. preparation of an inventory of existing A-V-T programs then in operation. The purpose of the inventory was to become acquainted with the overall aims of A-V-T programs.

2. obtaining the approval of the entire geography faculty to develop the A-V-T program.

3. assigning of two staff members to develop the A-V-T program. A very important consideration of this assignment was the released time given to these staff members for working on the program.

4. visits to twelve institutions having A-T and A-V-T facilities. The academic areas using these facilities included biology, botany, geography, geology, earth science, soil science, and physiology. The first-hand observations of these facilities, and the interviews with program directors were considered the most rewarding and valuable parts of the pilot program.

Following careful assessment of all background materials, the laboratory was designed, equipment was selected, the lesson units and other teaching materials were prepared, and a limited number of students was chosen to test the effectiveness of the
several aspects of the course.

The A-V-T study area was equipped with study carrels, tape players, slide projectors, and other teaching-learning materials. In general, the equipment components performed satisfactorily. It was noted, however, that the major equipment problem was with the operation of the tape players. The directors of the institutions visited, in fact, also reported that their major equipment problem was with the tape players. (This factor was especially interesting to the investigator in this research because, although relatively unsophisticated and inexpensive tape players were used, there were absolutely no mechanical failures of equipment, including tape players. This was true even though the five study carrels and equipment were used from ten to twelve hours each day, five days per week).

The stated purpose of the Western Michigan University report was to present, in some detail, the steps taken in setting up an independent study A-V-T program. It was reported that more data were needed before presenting the results of the program (the program had been operational for only one semester at the time). Preliminary findings, however, were sufficiently encouraging that the department planned to use the A-V-T approach for the entire introductory course in physical geography the following fall.  

Syrocki. In the final case, the report of Syrocki, and others, the A-V-T program initiated at the State University at Brockport, New York during the 1967-1968 academic year was described. The Department of Biological Sciences developed this independent study program as part of the basic Principles of Biology course. Approximately 1,000 students enrolled in this course during the first year of the A-V-T program.

The course was set up so that the students would spend at least two hours per week using A-V-T materials at the Tutorial Center. In addition, two class meetings were scheduled each week. At one of these meetings, the work of the previous week's tutorial was reviewed through presentation of materials and discussion led by an instructor. The remaining class period was used for showing films and presenting guest lecturers.

The Tutorial Center was housed in two large rooms, each of which contained twenty-four study carrels, equipped with a recorder/playback deck, headset, and foot control pedals.

A unique feature of the Brockport program was the implementation of television viewing. Short television modules on given topics were prepared on video tapes. Each TV module was prepared in the television studio of the Biology Center. These modules included topics such as The Chloroplast and The Mitochondrion. One study carrel was equipped with a ten-inch television set connected to an Ampex video playback machine. A dialing system was provided with the TV set, through which the
student could dial-in the desired television program.

A second unique feature was the Self-Testing Center in the Tutorial Center. When the student completed a prescribed study unit, he could evaluate his own achievement. This was accomplished by using a booklet of questions and answers, with approximately twenty-five to thirty-five questions being prepared for each week's work. The questions and answers were written on 5 x 8 inch note cards, and placed in a looseleaf notebook. The student, then, merely flipped the cards as he went through the booklet.

Evaluation of the student's work in the course was accomplished by administering four one-hour examinations, a final examination, and evaluation of his work in the study guides used in the Tutorial Center.

Syrocki emphasized that the Brockport independent study program:

1. encouraged the student to work independently.
2. functioned at the convenience of the student.
3. allowed the student to work at his own pace.
4. did not force the student to proceed from one step to another until he was ready to do so.60

The purpose of this report, as in the case of the Western Michigan University report, was to describe rather than to evaluate.

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The apparent enthusiasm of the authors in preparing the report, though, would seemingly indicate that they were reacting favorably to the A-V-T independent study programs.

The value of these reports concerning audio-tutorial and audio-visual-tutorial approaches to independent study, for this research, was that information about existing A-T and A-V-T programs was provided, why these programs were developed, how they were implemented, and some of the general effects of such programs.

**Evaluative Research Concerning Audio-Visual-Tutorial Approaches to Independent Study**

There have been few evaluative studies concerning independent study, especially of educational programs involving the use of audio-visual-tutorial systems. It was reported in 1967 that there were few specific research results which differentiated independent study programs and, furthermore, systematic evaluation of these programs appeared to be almost totally lacking. Cyphert advised that the literature was full of testimonials to successful programs but virtually void of remarks unfavorable to independent study practices. Maccini, at The Ohio State University, noted the lack of quantitative studies of independent study programs, and Thompson and Dressel reported that, in a survey of

63Maccini, op. cit., p. 13.
independent study practices, very little evaluation of independent study has been completed. Hoffman and Druger stated that, as of early 1971, there had been no attempt to analyze and compare the relative effectiveness of the different audio-tape strategies being used in audio-tutorial instruction.65

Of the few available evaluative reports, three seemed appropriate for inclusion in this chapter on the literature of independent study. The studies of Maccini and Bybee were of special interest because the subject matter areas of these research reports were similar to that evaluated in this investigation. The third report, that of Hoffman and Druger, was concerned with audio-tutorial instruction in biology.

Maccini. The purpose of Maccini's study was to evaluate the effectiveness of the audio-visual-tutorial program which served as the laboratory portion of the introductory geology course at The Ohio State University. Student attitudes, interest, achievement, and behavior during the laboratory sessions were investigated in an attempt to formulate an analysis with curriculum improvement in mind. In addition, it appeared that certain data dealing with student characteristics, achievement, and time-use of carrels in the self-instructional aspect of the program, could be appropriately analyzed through a multivariate analysis for the

64 Thompson and Dressel, op. cit., pp. 392-395.

purpose of predicting success in the laboratory program.\textsuperscript{66}

The goals of the A-V-T tutorial laboratory program included:

1. maximum use of available facilities.
2. serving the needs of large groups of students.
3. improving the effectiveness and efficiency of presenting laboratory materials.
4. providing uniform laboratory assistance for all students.
5. increasing both the scope and coverage of laboratory instruction, while maintaining approximately the same student time commitment.
6. improving the effectiveness and efficiency of the graduate student teaching staff, while maintaining the present number of teachers.
7. providing laboratory instruction with sufficient flexibility that the needs of both the slow and rapid learners would be effectively served.

In attempting to attain these goals, the design of the A-V-T laboratory and the nature of the program brought about changes in the laboratory program considerably different from conventional offerings. For example, prior to use of the A-V-T program, there were four lectures each week in addition to laboratory work. The efficiency provided by the A-V-T program allowed

\textsuperscript{66}Maccini, \textit{op. cit.}, pp. 15-16.
reducing the lectures to three each week, while the combination of three lectures and the A-V-T laboratory program allowed for an increase in the number of geologic concepts that could be treated.\textsuperscript{67}

The A-V-T laboratory was outfitted with twenty-four study carrels, each equipped with a filmloop projector with headset, a slide projector, a desk lamp, and appropriate teaching-learning materials.\textsuperscript{68}

The investigation was completed in a series of phases during the academic year, 1968-1969. As a result of the preparatory phase, Phase One, which was completed during the Autumn quarter, 1968, the following information was realized:

1. A collection of examination questions (multiple-choice items) was prepared and evaluated for discrimination and difficulty. Of the initial 120 questions, 100 were retained for use in the study.
2. Students found testing before and after the laboratory sessions to their liking. It was found, moreover, that "the ideal unit quiz should not contain more than ten items since these could be completed in less than ten minutes."
3. Students hesitated to seek aid; many were not appreciative of the type of assistance provided in the labor-

\textsuperscript{67}Ibid., pp. 24-25.

\textsuperscript{68}Ibid., pp. 26-28.
atory.

4. Better reinforcement through answers supplied during the laboratory sessions was insisted on by a number of students.

5. Many students appeared to like the use of movies and programmed laboratory assignments.

Phase Two, completed during the Winter quarter, 1969, involved approximately 500 students in the A-V tutorial program; slightly more than one-half of this number was assigned to the study group. The purpose of Phase Two was to collect data in which the following information was yielded:

1. item analysis of each unit achievement test.
2. ratings of specific areas of the course.
3. general attitudes of students toward the program.
4. taped interviews of the students and laboratory staff.
5. time-utilization of the carrels.
6. an achievement final examination based upon items selected from unit quizzes.

Maccini reported that, during Phase Two, the entire population was available for collection of data only part of the time; in other instances, random sampling was required.69

Unit pre- and post-achievement tests and unit media-assessment questionnaires were administered to students, using random sampling techniques. Prior to testing each week, a group

69Ibid., pp. 20-22.
of 135 students was isolated from the population, using a table of random numbers. The first forty-five students completed the unit post-test. The second forty-five completed both the pre- and post-test for the unit. Finally, the third forty-five students completed the unit media-assessment questionnaire. Although all the students had been oriented to the testing schedule, none had advance knowledge as to the nature of the items given each week or of the actual selection of individuals for testing.\textsuperscript{70}

A general attitude questionnaire was administered at the conclusion of the course. All students completed the questionnaire, although a random sample of forty-four students was selected for regression analysis.\textsuperscript{71}

Taped interviews were conducted during the last week of the course. Students were asked to provide a subjective evaluation of the procedures and materials used in the A-V-T program. These interviews were completed in privacy.

In the treatment of the data, Maccini completed several operations. These included:

1. an item analysis of student responses to the nine unit achievement tests, based upon unit objectives. Each question was analyzed from several standpoints:
   a. statement of question, possible answers and correct answer.

\textsuperscript{70}\textit{Ibid.}, pp. 21, 59.
\textsuperscript{71}\textit{Ibid.}, p. 66.
b. per cent of students responding to each answer on pre- and post-tests.

c. difficulty and discrimination.

d. the objectives of each question.

The item analysis of each unit was further presented in longhand form. Items which were believed to be acceptable according to difficulty and discrimination were selected for inclusion in the final examination.\textsuperscript{72}

2. media assessment. Students were asked to evaluate the various media used in the program in terms of liking, interest, difficulty, appropriateness and informativeness. Utilizing a semantic differential scale evoking affective student responses to various media, the scales were analyzed in a general way. The purpose was to determine ideas for curriculum improvement and report any significant trends in assessment of media.

The report indicated that, with regard to specific media, movies were rated generally highest, followed in decreasing order by slides, earth materials, models, and the laboratory manual.\textsuperscript{73}

Maccini indicated some doubts about the use of the Smith, Walberg, Poorman and Schagrin Media Assess-

\textsuperscript{72}\textit{Ibid.}, pp. 70-110.

\textsuperscript{73}\textit{Ibid.}, pp. 115-131.
tend to maintain better scores upon leaving the laboratory.\textsuperscript{75}

b. "There will be no significant differences between the means of students' scores on unit post-tests (Form B), and means of scores on unit post-tests (Form A) for any given unit." It was found that the null hypothesis was accepted for each of the laboratory achievement post-tests, except one. The high critical-ratio value for one of the units was explained as chance convergence of mean scores. In the testing of these hypotheses, using T-Test (critical ratio) determination, Maccini reported that, although there was no way of testing for determination of "true" scores on these tests, it was determined that:

1) all post-test scores were higher than pre-test scores.

2) all post-test scores, except one, were significantly higher; some at the .01 level and others at the .001 level.

3) moderate correlation values were realized for most of the unit pre- and post-tests.

The conclusion was thus made that the practice of pre-testing students as was accomplished in the study

\textsuperscript{75}ibid., pp. 110-112.
had little effect on post-test scores.\textsuperscript{76}

c. "A student's sex will not be related to attitudes toward the A-V tutorial laboratory." A computed t value of .071 resulted in acceptance of the null hypothesis (the required value being 2.02 at the .05 level, with 40 degrees of freedom).\textsuperscript{77}

d. "Success in the university undergraduate program will not be related to success in the A-V tutorial laboratory." The computed t value of 4.82 resulted in rejection of the null hypothesis (the required value being 2.02 at the .05 level, with 40 degrees of freedom).\textsuperscript{78}

e. "Time spent in the use of AVT carrels will not be related to success in the A-V tutorial laboratory." A computed t value of .61 resulted in acceptance of the null hypothesis (the required value being 2.02 at the .05 level, with 40 degrees of freedom).\textsuperscript{79}

f. "Student general attitude toward the A-V tutorial laboratory will not be related to success in the A-V tutorial laboratory." The computed t value of 1.42 resulted in acceptance of the null hypothesis (the

\textsuperscript{76}Ibid., pp. 112-115.

\textsuperscript{77}Ibid., pp. 133-134.

\textsuperscript{78}Ibid., 135-136.

\textsuperscript{79}Ibid., pp. 137-138.
ment Questionnaire. It apparently had been used only once before (at Harvard, in Project Physics) and, indeed, the possibility existed that the usefulness of this form for the specific purpose of assessing audio-tutorial programs needed itself to be investigated.\(^{74}\)

3. testing of the null hypotheses. Each hypothesis will be stated, and will then be immediately followed by the findings for that hypothesis.

a. "There will be no significant difference in the means of students' scores on each unit pre-test, and the means of unit post-tests taken by these same students." It was found that significant differences existed between means of pre- and post-test scores for all laboratory unit examinations except one (a sufficient number of cases was not available to adequately test the last unit). Thus, significant score gains were made by the students in each of the first eight units. Product-Moment, Pearson r correlation values (ranging from .19 to .78) indicated at least a moderate correlation between scores gained upon entering the laboratory and achievement measured upon leaving. Maccini suggested that this measurement indicated that many students, bringing better backgrounds to the A-V-T laboratory, will

\(^{74}\)Tbid., p. 110.
required value being 2.02 at the .05 level, with 140 degrees of freedom). 80

4. open scheduling of visits to the A-V tutorial laboratory. Carefully-kept records of student attendance revealed the following facts:

a. Errors in the sign-in, sign-out cards were limited to about four cards per laboratory unit.

b. Students did not attend the A-V-T laboratory at optimal times despite advice given in lecture meetings.

c. Students attended the laboratory in large numbers at the end of each week and during peak hours of the day. The attendance cards, of course, did not show the number of students waiting in line at these times. Mid-morning and mid-afternoon peaks of attendance were the rule.

d. A number of students apparently made multiple visits during the sixth and eighth weeks. The greatest number of visits was made during the third week.

e. Mid-quarter examinations, geology lecture periods, and the optional film time were considered as factors affecting attendance. 81

80 Ibid., p. 137.
81 Ibid., pp. 139-147.
5. personal interviews with students. Thirty-five students were interviewed using audio-tape recorders. Three categories of questions were asked concerning the laboratory materials and manual, individual instruction, and general comments.

The interviews supported the conclusion presented earlier concerning attitude, namely, that students favored the program. Other responses included:

a. favorable comments on scheduling which permitted students to determine their own laboratory schedule.

b. requests for more movies.

c. satisfaction with audio-visuals.

d. considerable satisfaction with laboratory assignments early in the program, and much concern for the difficulty of later assignments.

e. praise for laboratory assistants.\(^{82}\)

The conclusions reported by Maccini were:

1. Many geology departments are genuinely concerned about the proposed nature of undergraduate geology education, especially for the non-science major.

2. Although a number of universities have attempted innovations in geology curriculums in recent years, audio-visual tutorial laboratory systems have been primarily

\(^{82}\text{Ibid.}, \text{pp. 147-165.}\)
in the sciences, notably biology.

3. The majority of audio-tutorial programs implemented in the last decade were considered successful on the basis of instructor experience, rather than from carefully collected data.

4. The remaining conclusions were confined mainly to the reporting of findings presented earlier.\textsuperscript{83}

This report was especially valuable to the present investigation in that it provided discussions of the goals of the A-V-T laboratory program, design of the laboratory, teaching materials used, objectives of the teaching-learning units, and descriptions of the results of the study.

Bybee. The purpose of Bybee's study was to "determine the effectiveness of an individualized laboratory in a general education Earth Science class." Further, "to what degree do two general education Earth Science classes differ on both an objective and subjective analysis when one group has been exposed to an individualized laboratory approach with audio-visual enrichment while the second group has been exposed only to the lecture-demonstration method of teaching?"\textsuperscript{84} The research was conducted at Colorado State College during the Spring quarter, 1968.

The design of the evaluative study involved two factors:

1. comparing the achievement level of the experimental

\textsuperscript{83}\textit{Ibid.}, pp. 167-174.

\textsuperscript{84}\textit{Bybee, op. cit.}, p. 157.
and control groups at the end of the course.

2. comparing student attitudes at the end of the course.

The experimental class contained thirty students, the control group, seventy-nine students, for a total of 109 participants. It was noted that of the total number, a good many students had been involved in contemporary science programs (i.e., PSSC--23 per cent, Chem Study--32 per cent, BSA--7 per cent, BSCS--53 per cent, and ESCP--2 per cent).

The control group met three times each week for one-hour lectures taught with a staff-designed syllabus, covering the topic areas of geology, astronomy, and meteorology. Demonstrations and films also were included in the course.

The experimental group received two one-hour lectures each week which emphasized an integrated approach to earth science. All students in this group were required to attend one two-hour laboratory each week, as well.85

The first thirty minutes of the laboratory period was reserved for a group activity which included short investigations, inquiries into problems presented by the instructor, and discussion of problems related to the lecture. The remaining ninety minutes were reserved for the students.

The individualized laboratory was unique in that students could work alone or with others on activities, and could participate in activities involving self-direction and interest.

85Ibid.
Students were free to do only laboratory investigations, utilize only A-V materials, or do individual projects. A wide range of equipment such as film loop projectors, teaching machines, and film strip projectors, with associated teaching-learning materials were available for student use at the Science Education Auto-tutorial Center. The Center also contained a small science library.

Relevant steps in the evaluation of this teaching method included:

1. Each class was pre- and post-tested with a 150 question comprehensive content examination, containing a Kuder-Richardson Formula 20 reliability of .848.

2. Examinations of fifty items each were administered in geology, astronomy, and meteorology during the quarter, as well. The reliabilities of these examinations were found to be .68, .65, and .57, respectively.

3. Students completed an attitude scale in which they rated various components of the class in which they were enrolled.86

The related questions and findings were, as follows:

1. "Is there a statistically significant difference at the .01 level of confidence between the experimental group and the control group on a comprehensive Earth

86 Ibid., p. 158.
Science post-test after controlling pre-test differences?" Analysis of covariance was used to test the first question, wherein the pre-test mean score was used as the covariate and the criterion variable was the post-test mean. A t test of unrelated measures resulted in a t value of 0.0579 which was not statistically significant at the .01 level of confidence.87

2. "Is there a statistically significant difference at the .01 level of confidence between the experimental group and the control group on a subjective analysis of the general education Earth Science class in which they were enrolled." An evaluation inventory was prepared for student use. Examples of criteria included in the inventory were:

Class Rating

Dull, routine, monotonous vs Stimulating, imaginative, exciting

Audio-visual materials vs Audio-visual materials
were of no help greatly helped my study of earth science

Comparison of this class with prior lab.-oriented science classes, i.e., FSSC

Inferior in every respect vs Superior in every respect

Rating of Instructor

Aloof, egocentric, restrictive behavior vs Friendly, understanding behavior

87 Ibid.
Laboratory Evaluation

Laboratory was ineffective— vs Laboratory was effective—contributed nothing to the class vs contributed to the class greatly

Chi-square was used to test the items in the subjective questionnaire. This statistical device was used to determine the degree of closeness an obtained frequency fits an expected frequency. The expected results in this report consisted of the control responses to the items on the Student Inventory. These results were compared with the results of the experimental group. Following calculation of the chi-square value, the level of significance for the obtained value was checked. The results of this test indicated that there was a statistically significant difference between the control and experimental groups in all fourteen of the categories at the .001 level of confidence.

Bybee concluded that students enrolled in the experimental group in this individualized earth science laboratory study achieved as well as the control group on an objective comprehensive Earth Science examination. Further, the students in the experimental group of this study rated the course significantly higher than did the students in the control group.88

Hoffman and Druger. Hoffman and Druger compared two audio-tape strategies with the goal of determining their effect on student

88 Ibid., pp. 158-160.
achievement, retention, attitudes, problem-solving abilities, and critical thinking abilities. The experiment took place in a general biology course at Syracuse University, during the fall term, 1968. Ninety students were randomly selected from the more than 800 students enrolled in the course. The ninety subjects were randomly divided into two equal-sized groups. Both groups were taught in separate "open" audio-tutorial laboratories, but by different audio-tape strategies.

Each laboratory contained six study carrels, each equipped with a tape recorder, microscopes, slide viewer, and appropriate teaching-learning materials. In addition, each laboratory room contained a demonstration table and a reference library. A film loop projector was placed on the demonstration table. Students were provided lesson guidesheets, as needed.

Students signed up for one or more two-hour blocks of laboratory time at the beginning of each week. Although there were no discussion periods or lectures, there was one outside meeting each week held for the purpose of administering examinations and providing information.

Both groups were taught the same subject matter during the six-week period of experimentation. Different audio-tape teaching strategies, however, were used with each group.

The direct group received lessons of a descriptive nature that provided little opportunity for the student to actively

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89Hoffman and Druger, op. cit., pp. 149-155.
participate in the learning process other than by notetaking. The emphasis was on listening to the tapes, examining film loops, diagrams, slides and guidesheets. The student thus was to follow steps suggested on the audio-tapes.

The indirect group, in contrast, was taught by a lecture-question-answer method in which the student followed an investigatory approach for reaching the objectives. Lecturing was minimal in the program. This group examined the same film loops, slides, and demonstration materials as did the direct group. The guidesheets and diagrams, however, contained only a skeletal framework to guide the learning. The student, then, through the use of the guidesheets, developed answers to questions, and formed his own conclusions in the solving of problems. There was thus considerably more student-teacher interaction within the taped lessons of the indirect group.90

In terms of relevance to the present investigation, Hoffman and Druger prepared several kinds of materials to be tested and analyzed. These were:

1. the Watson Glazer Critical Thinking Exam, form Ym, used to measure critical thinking changes and transfer of learning abilities.

2. preparation of a sixty-item subject matter examination, with a Kuder-Richardson Formula 20 reliability of 0.86.

3. division of the sixty-item test into two types of ques-

90Ibid., pp. 149-150, 155-156.
tions:
a. knowledge type questions--forty of the sixty items, and found to have a reliability of 0.82.
b. use of knowledge type questions--twenty of the items, and found to have a reliability of 0.60.

4. preparation of an attitude questionnaire used to sample student opinion concerning biology and genetics as course subjects, the audio-tutorial method of instruction, and the indirect teaching method. This forty-four item questionnaire was one in which the student provided any one of five responses (i.e., scaled from 5 to 1 for strongly agree, agree, neutral, disagree, and strongly disagree). 91

The test instruments were used both before and following the experimental period in order that the results could be used to test several hypotheses. The null hypotheses and findings were:

1. "At the conclusion of the experimental period, the two groups will not differ with respect to their mastery of facts, concepts, and principles concerning heredity as measured by a subject matter exam prepared by the investigator." A computed t value of .949 resulted in acceptance of the null hypothesis (the required value being 1.99 at the .05 level, with 85 degrees of free-

91 Ibid., pp. 152-153.
2. "At the conclusion of the experimental period, the two groups will not differ with respect to their problem-solving ability as measured by the use of knowledge questions from the investigator's subject matter exam." A computed t value of 3.03 resulted in rejection of the null hypothesis (the required value being 1.99 at the .05 level, with 85 degrees of freedom).93

3. "The two experimental groups will not differ with respect to their ability to retain factual and conceptual information as measured by a subject matter test prepared by the investigator." A computed t value of 1.07 resulted in acceptance of the null hypothesis (the required value being 1.99 at the .05 level, with 85 degrees of freedom).94

4. "At the conclusion of the experimental period, the two groups will not differ with respect to their ability to think critically and to transfer learning to other situations as measured by the Watson Glazer Critical Thinking Exam, form Ym." A computed t value of .18 resulted in acceptance of the null hypothesis (the required value being 1.99 at the .05 level, with 85 degrees of freedom).

92Ibid., p. 153.
93Ibid.
94Ibid.
degrees of freedom).95

5. Three null hypotheses were tested with regard to the attitude questionnaire. These were:

"At the conclusion of the experimental period, neither group will show a difference from their original attitude toward:

a. biology and genetics as course subjects.
b. the indirect teaching strategy.
c. the audio-tutorial method of instruction."

Further, the items on the questionnaire were assigned to one of three categories. The hypotheses were examined according to three questions:

a. "Were there any individual items which showed significant changes between the pre-test and the post-test for either group?
b. If there were any significant changes, what were the directions of change: increase or decrease (positive or negative)?
c. Was there a significant difference between the number of items showing a positive shift and the number of items showing a negative shift in attitude for either group?"

The use of chi-square tests were used to determine the number of test items for each group which contri-
buted to the attitude changes to a significant degree.
The following results were indicated:

a. **Indirect Teaching Strategy** - The indirect group believed there was sufficient information given on the guidesheets; the direct group did not. Neither group believed students should be made to search for knowledge, but both groups liked the weekly quizzes.

In general, the students believed that the merits of audio-tutorial instruction far outweighed the shortcomings. Students liked the atmosphere, the personal attention, the opportunity for self-expression, and the use of tapes in place of formal lectures.

b. **Positive vs Negative Shifts (biology and genetics)** - Of the ten items related to biology, both groups responded with five positive and five negative shifts. Of the six items related to the indirect strategy, both groups responded with three positive and three negative shifts. Neither group reflected a significant change from their original attitudes. The null hypotheses related to these aspects were therefore accepted.

c. **Audio-tutorial Method of Instruction** - Of the twenty-eight items concerned with audio-tutorial
instruction, the direct group showed twenty-eight positive and zero negative shifts, the indirect group, twenty-six positive and two negative shifts. This great number of positive over negative shifts resulted in rejection of the null hypothesis.\textsuperscript{96}

It was concluded that the tape analysis instrument developed during the study did provide a means of objectively analyzing the directness or indirectness of taped instruction. Further, the results obtained in the study indicated that there were not highly significant differences between the two groups. It was felt that such evaluative studies might provide guidelines for future audio-tape program development.\textsuperscript{97}

The Hoffman-Druger report was valuable to the present investigation in the manner in which the hypotheses were stated, and the manner in which the data collection and treatment were presented.

\textbf{The Literature Review and Guidelines for the Present Study}

A careful examination of two of the three evaluative reports discussed above provided a number of guidelines which greatly aided in the development of this present research. These were the studies of Maccini and Bybee. The report of Hoffman and Druger was not yet available at the time the present

\textsuperscript{96}Ibid., pp. 154-155.

\textsuperscript{97}Ibid., p. 155.
investigation was initiated. Some of the factors from this last study, however, will be included in this discussion.

Selected for more detailed comment at this time were two types of information. The first of these included data from the above reports which applied directly to the investigator's research. The second was information which the investigator believed was unique to his study, either because the approach used was different from those described in the review of the literature or because such information was not included at all in other studies listed in the review.

Maccini's work was of especial value in the following ways:
1. Through study of his comprehensive description of the necessary physical facilities, together with a personal interview and visit to the laboratory used in his study, the investigator was assisted greatly in determining the type of A-V-T study carrel arrangement which would best meet the needs of his own research problem.

2. Although numerous changes were made as the study progressed, initial use of Maccini's general format was of real value in the preliminary planning of this research. Information on types and amount of data needed, use of hypotheses to be tested, use of multimedia assessment, and student attitudes toward the A-V-T program were all useful at this time.
3. Maccini found that the use of the A-V-T program allowed him to reduce lecture periods from four to three per week, but at the same time provided increased coverage of the content material in geology.

One of the problems of the present investigation was the need to teach an entire course to 110 students, using only five study carrels. This limited each student to approximately two hours of carrel study time each week. Maccini's success helped to convince this investigator that he would be able to cover the needed physical geography-earth science content successfully during the time available.

4. Maccini's use of a pilot study prior to the actual period of research data collection convinced the investigator that such a practice would also be advisable in the present study. This initial period proved to be invaluable in determining if the students would be able to complete all the phases of the modified program within the prescribed time available, and also if students would be able successfully to complete laboratory investigations and other activities of the course.

5. The investigator was particularly interested in the attitude scale prepared by Maccini. This scale was directly associated with his A-V-T program. The use of an attitude scale in this research will be described later in
this discussion.

6. The investigator was impressed by the personal interview technique used by Maccini, that is, use of tape-recorders to obtain the students' personal views of the A-V-T program. This type of technique also was used in the present investigation.

The report of Bybee also was helpful in developing the present investigation in several ways. The most important of these were:

1. Bybee conducted research which involved comparing differences between an experimental group and a control group. This was of special interest because the present investigation involved comparing differences within an experimental group. A more complete discussion of this topic will be found below.

2. Bybee briefly explained the use of a statistical technique, that of chi-square. It was this explanation, coupled with a similar kind of explanation of a statistical technique in the present research that led the investigator to develop a recommendation related to discussion of statistical techniques in future studies.

3. The investigator was impressed with the clear manner in which Bybee reported the testing of his hypotheses, and attempted to do likewise in the present investigation.
As previously stated, the Hoffman-Druger report was not yet available at the time the present research was initiated. The investigator was sufficiently impressed, however, with the clear and succinct manner in which they reported the results of testing their hypotheses, that he used a similar format.

Although these studies were of definite value in the planning and completion of this research, the investigator believed that certain unique features not listed in the literature, or that used a different approach, were included in his program. Among these were:

1. In the review of the literature, in all reports where A-V-T equipment was described, it appeared that the equipment was relatively sophisticated and expensive. This was sometimes verified by pictures accompanying the reports. For his research, the investigator desired to utilize equipment that was relatively inexpensive and unsophisticated, equipment that would stand up under the strain of many continuous hours and days of use. The successful use of such relatively inexpensive equipment might allow and even encourage future researchers to further investigate problems of A-V-T instruction.

2. Whereas the other studies all involved at least some formal classroom time, all the course requirements in this investigation were completed in the study carrel
area with no formal classroom instruction. This practice appeared to remove another variable that would have been bothersome to this research.

3. Other studies involved "mixtures" of students such as upper and lower classmen. All the students in this investigation were matriculating freshmen. These, then, were students who had not yet been "tainted" by other factors of university life. In addition, because the period of data collection was during the Autumn quarter, outside university influences were still minimal.

4. One segment of this investigation concerned the development of test questions representing a number of kinds of thought processes as defined by Bloom and Sanders.

5. The review of the literature in this research assembled, apparently for the first time, both information on the earlier one-to-one teacher-student relationship kind of independent study and that of the more modern technological view of A-V-T independent study.

6. This investigation appeared to be the first evaluative study which discussed a perspective of independent study.

7. Whereas Bybee compared differences between an experimental and a control group, Maccini compared differences among a number of random mixtures of 270 students
within an experimental group, and Hoffman and Druger compared differences between two experimental groups, in this research the investigator used a still different approach, that of comparing differences between two groups within one experimental group.

8. The Maccini and Bybee studies utilized attitude scales prepared by the researchers to determine student attitudes toward their particular research programs. For the present study, the investigator used a different approach. He believed that these attitudes would be best ascertained through personal interviews administered at the end of the program. He did desire, however, to determine if there was a positive or negative change in attitude toward science and scientists because of learning science content through the modified A-V-T method. Therefore, he used an attitude scale prepared by Cummings at The Ohio State University. This scale is more fully discussed elsewhere in this report. It was believed, however, that this scale was quite adequate for use in this investigation.

9. For purposes of testing his hypotheses, Maccini divided students into groups based on achievement test scores. Primarily, comparisons were made between the upper and lower 27 per cent groups. With this as
a base, he then matched appropriate variables with the students' test scores. For this research, the investigator divided students into upper and lower 27 percent groups based upon several variables. With these as bases, he then matched appropriate mean gain of achievement scores on tests with the students' position within the given variables.

The above factors, then, and others discussed elsewhere in this report, were utilized in developing, implementing, and completing this research.

**Summary**

This chapter on the review of the literature of independent study presented six topics. The topics and their concerns were:

1. Perspective on independent study.
   The history of the independent study movement in the United States, early emphases in independent study programs, and a philosophy of independent or individualized study were presented.

2. Definition of independent study.
   Individualized instruction on an approximate one-to-one basis, and audio-tutorial and audio-visual-tutorial instruction methods were presented.

3. Independent study, a traditional view.
   Higher education institutions that have offered inde-
dependent study programs on an approximate one-to-one individualized basis were presented, as well as some of the types of programs offered, requirements, and outcomes of such programs.

4. Audio-tutorial and audio-visual-tutorial approaches to independent study.

Several of these programs were described in detail.

5. Evaluative research concerning A-V-T approaches to independent study.

Three A-V-T programs were discussed at length concerning development of the programs, student involvement, data collected, and treatment of the data.

6. The literature review and guidelines for the present study.

A number of guidelines which proved valuable in the present investigation were discussed. In addition, unique features of this investigation as they related to information in the literature review were presented.

In Chapter Three, the Ball State University physical geography-earth science A-V-T program will be presented as it related to this research. The reader will find detailed discussions of the facility, classroom procedures, materials studied, students involved, testing, attitudes, interviews, data collection, and treatment of the data.
CHAPTER III

THE BALL STATE UNIVERSITY PHYSICAL GEOGRAPHY-EARTH SCIENCE AUDIO-VISUAL-TUTORIAL PROGRAM

**Introduction**

The independent study concept (A-V-T) utilized in teaching the general education physical geography-earth science course in this investigation was entirely new to the geography-geology-earth science program at Ball State University. Closed-circuit television had been used for several years as a teaching method. Programed instruction and laboratory work had been included in the basic course. Independent study, however, was not being used as a teaching method. Could the independent study method, utilizing audio-visual-tutorial methods be used to teach this course, and would the students learn? The investigator decided to try.

The purpose of this chapter was to describe the modified physical geography-earth science A-V-T independent study program at Ball State University during the period of the research. The topics included were:

1. the independent study room facility.
2. classroom procedures.
3. content, objectives, activities, and materials.
4. the student sample under study.
5. the achievement tests.
6. the attitude scale.
7. the student interviews.
8. the data collection.
9. treatment of the data.

The Independent Study Room Facility

Five study carrels (Fig. 1, p. 88) were constructed in a
room approximately 16 x 22 feet, on the fourth floor of the
Cooper Life Science Building at Ball State University. An
try was made to develop the facility for most efficient and
effective student use. The one-hundred students completed all
the requirements of the course in this room. Each carrel was
equipped with:

1. a Panasonic RQ-209AS Keyboard Type Cassette Tape
   Player-Recorder (playable on either alternating cur-
   rent or batteries).
2. a Calrad 15-110, HP-2 Stereo Headphone Set, adapted
   for use with the Panasonic player.
3. a Kodak 650 Slide Projector, and ten-inch screen.
4. a Carrel Notebook, containing sketches and other mat-
   erials that supplemented the tape cassette lectures
   and laboratory investigations.
5. a 6-inch Replogle globe.
6. other materials and equipment, as needed.
Fig. 1. Study Carrels with Tape Players, Slide Projectors, and other Materials.

Two tables, located behind the study carrels, provided ample space for five laboratory set-ups where the students completed the laboratory investigations with equipment too large or bulky to be used at the carrels. A room supervisor's desk and two cabinets for storage of laboratory and test materials were also placed in the study room.

Classroom Procedures

The study room initially was open from 8 A.M. to 6 P.M., Monday through Friday. Each student selected two hours per week when he would use a study carrel. These two hours, once selected, were reserved for that student. In addition, students
were allowed to use the study carrels at the times not scheduled by other students. After the first two weeks, some students asked for additional study time. The study room hours were then extended to three evenings per week from 6 P.M. to 10 P.M., student use being on a first-come, first-served basis.

The usual routine for the student using a study carrel was:

1. Sign in at the desk, giving name and time of arrival.
2. Take the pre-test for the assigned unit.
3. Listen to the beginning of the assigned tape cassette for objectives of the assignment and further instructions.
4. Move from the study carrel to laboratory apparatus, as requested, returning to the tape player for further instruction and information.
5. Complete laboratory assignments.
6. When the total assignment is completed, take the post-test for the assigned unit.
7. Sign out at the desk, recording the time of leaving.

The amount of time and number of times the student spent at the study carrel area were carefully recorded.

Student orientation to the teaching method and use of equipment occurred during the first class meeting. The science-scientist attitude scale was given during the second meeting, the fifty-question comprehensive pre-test at the third meeting. The routine described above began with the fourth meeting. At
the initial meeting, the students were told what materials to purchase at the University Book Store: an earth science manual,98 an atlas,99 and a rock and mineral kit.100 The students were asked to bring the manual each time they used the study carrel. The atlas and rock and mineral kit were to be brought to the classroom at appropriate times.

Content, Objectives, Activities, and Materials

The investigator based much of the lecture and laboratory materials on content developed in the Earth Science Curriculum Project.101 The emphasis was placed upon enlarging the student's general education in science within the rationale of the Ball State University general education philosophy, which is stated, as follows:

Principles, understandings, skills and values from all the major fields of knowledge are usually included in the common studies, i.e., the basic program of prescribed courses in general education. The common studies, which emphasize the relation and unity of basic ideas and concepts from the several disciplines, are selected on

---


100Iyclif Enterprises (Muncie, Ind.: Iyclif Enterprises, 1971), thirteen mineral and seventeen rock specimens, streak plate.

the basis of their usefulness in helping to solve the common problems of men in both an individual and a social context.102

In order that the reader may be more fully informed of the types of content, objectives, activities completed by students, and materials used in the teaching-learning units, outlines of two units are included in their entirety. The information for the remaining units may be found in Appendix I. Further, the lectures which were placed on audio-tape cassettes for these two units may be found in Appendix II.

Unit One Earth Measurements

Content: This unit includes an audio-taped lecture and laboratory work concerning the shape of the earth, the size of the earth, and how one may locate himself (or any object) on the earth surface (the importance of the grid system and latitude and longitude).

Objectives: Upon completion of this unit, the student should be able to:

1. describe the size and shape of the earth,

2. use linear and angular measurements in establishing location on the earth surface, and

3. identify and describe the differences between

102Ball State University, General Studies Program (Muncie, Ind.: Ball State University, undated brochure), p. 2.
great and small circles on the globe.

Activities:

1. Pre-test, Unit One

2. Examination of slides
   a. Salt flat in western United States
   b. Four slides concerned with latitude and longitude

3. Examination of Apollo 8 and Apollo 9 photographs

4. Examination of sketches in Carrel Notebook
   p. 1 Oblate spheroid shape of the earth
   p. 2 Ship disappearing from shore at about eighteen miles
   p. 3 Eratosthenes' measurement of earth circumference

5. Completion of Exercise 1, Earth Science Manual

6. Use of a globe and rubber band to demonstrate great and small circles

7. Use of a globe to demonstrate latitude and longitude

8. Post-test, Unit One

Materials:

1. 6-inch Replogle Globe

2. Slides
   a. Salt flat in western United States
   b. Parallels and latitude
   c. Meridians and longitude
   d. Latitude and longitude on rectangular grid system
e. Latitude and longitude on globes and spheres, and world rectangular projection

3. Carrel Notebook (Appendix III)
   a. p. 1 Earth Shape - Oblate Spheroid (exaggerated view)
   b. p. 2 Effect of Earth Curvature on Ship Disappearing from Shore at about Eighteen Miles
   c. p. 3 Eratosthenes' Measurement of Circumference of Earth

4. Apollo 8 and Apollo 9 photographs

5. Rubber band

6. Earth Science Manual, Exercise 1

7. Tape Cassette Lecture, Unit One Earth Measurements (Appendix II)

8. Pre- and post-tests, Unit One (Appendix V)

Unit Three Meteorology - Energy and Air Motion

Content: This unit includes two audio-taped lectures and laboratory work concerning Meteorology - Energy and Air Motion, including radiation, convection, and conduction, temperature, pressure, wind relationships, and effects of differential heating and cooling of land and water upon general air circulation.

Objectives: Upon completion of this unit, the student should be able to:
4. Examination of four slides of weather instruments
5. Examination of globe for land-water distribution discussion
7. Post-test, Unit Three

Materials:
1. Radiation Kit - ESCP
   a. 1 black cup
   b. 1 silver cup
   c. 2 Centigrade (Celsius) thermometers with styrofoam inserts for securing thermometers into cups
   d. 150-watt lamp and support
2. Laboratory instruction sheet for radiation investigation (Appendix IV)
3. Carrel Notebook (pages as noted above in Activities)
4. Slides
   a. Weather instrument shelter
   b. Maximum and minimum thermometers, psychrometer
   c. Wind vanes and anemometers
   d. Mercurial barometer and aneroid barometer
1. provide an explanation of the radiative balance of the earth and the energy budget,
2. describe the heating processes of radiation, convection, and conduction,
3. account for the different rates at which energy is absorbed by land and water,
4. explain how the spherical shape of the earth and its rotation help determine the distribution of incoming radiation,
5. describe Coriolis Effect,
6. explain the relationships between temperature and pressure as they relate to wind patterns, and
7. recognize the use of several weather instruments.

Activities: 1. Pre-test, Unit Three
2. Completion of radiant energy investigation
3. Examination of sketches in Carrel Notebook
   a. p. 4 Concentration of sun rays at different latitudes
   b. p. 5 Convection
   c. p. 6 Constructing a mercurial barometer
   d. p. 7 World Wind Belts
   e. p. 8 Sea breezes - Land breezes
   f. p. 9 Valley breezes - Mountain breezes
   g. p. 10 Pressure Cells
5. Belfort portable wind measuring set #6052
6. Ten-inch electric fan
7. Laboratory instruction sheet for wind measurement investigation (Appendix IV)
8. Tape Cassette Lecture, Unit Three, part one, Meteorology - Energy and Air Motion - Heating and Weather Instruments (Appendix II)
9. Tape Cassette Lecture, Unit Three, part two, Meteorology - Energy and Air Motion - Differential Heating, Winds, and Pressure Cells
10. Pre- and post-tests, Unit Three (Appendix V)

The equipment and supplies used in the lesson units were acquired from several sources. These were:

1. Earth Science Curriculum Project (ESCP) materials were loaned to the investigator by Houghton Mifflin Company.
2. Other laboratory materials were provided by the Geography and Geology Department at Ball State University.
3. Landform/Geology prints were obtained from the A.J. Nystrom Company.
4. Slides were obtained from:
   a. Wards Geology Slides.
   b. reproducing International Cloud Atlas pictures.
   c. the private collection of the investigator.
5. Mineral and rock kits were prepared by the investi-
August. Enrollment of matriculates admitted with distinction occurs during the first two weeks, that of students admitted with warning during the last two weeks, and that of regularly admitted students during the remaining period.\textsuperscript{104} The matriculating freshman class at Ball State University in the Autumn quarter, 1971, contained 3691 students. As shown in Table 2, 616 students (17 per cent) were admitted with distinction, 2971 (80 per cent) were admitted as regular students, and 104 (3 per cent) were admitted with warning.\textsuperscript{105}

\begin{table}
\centering
\caption{Matriculating Freshmen at Ball State University, Autumn, 1971}
\begin{tabular}{lll}
\hline
Student Admission Classification & Number Enrolled & Per Cent Enrolled* \\
\hline
Students Admitted with Distinction & 616 & 17  \\
Regular Admission Students & 2971 & 80  \\
Students Admitted with Warning & 104 & 3  \\
Total & 3691 & 100  \\
\hline
\end{tabular}
\end{table}

*Percentages rounded to nearest whole per cent

In selecting the student sample for this research, the investigator was assisted by the Ball State University Office of

\textsuperscript{104}Ball State University, \textit{Ball State University 1970-1972 Catalog}, 45, no. 1 (Muncie, Ind.: Ball State University, March, 1970), p. 23.

\textsuperscript{105}Information received from Ball State University Recorder's Office, January, 1972.
gator, using specimens he either collected or purchased.

The Student Sample Under Study

There are three categories of admission for freshman matriculates at Ball State University. These are: admission with distinction, regular admission, and admission with warning. Students admitted with distinction have demonstrated their potential for establishing a good academic record at the university. In order to be so classified they must rank in the upper twenty per cent of their high school graduating class and have a verbal score of 500 or higher on their Scholastic Aptitude Test (SAT). The regular admissions category is assigned to matriculates whose high school graduating class percentile ranking is at the 50th percentile or higher and whose SAT-verbal score is above 400. Students whose graduating class percentile ranking is below the 50th percentile, and whose SAT-verbal score is below 400, are usually admitted with warning. Admission is usually denied to applicants who rank in the lowest one-quarter of their high school graduating class and if their SAT-verbal score falls below 300.103

Enrollment of Autumn quarter freshman matriculates occurs during the summer from the third week in June until the end of

103Ball State University, Introducing Ball State, 1971-72 (Muncie, Ind.: Ball State University, Sept., 1971), pp. 16-17.
Curricular Advising. Every student entering Ball State University is assigned a curricular adviser. These advisers are familiar with course requirements and sequences and approve the student's course program for each quarter of the year.\textsuperscript{106} For the purpose of this research, the curricular advisers initially enrolled a stratified random sample of 110 freshman matriculates, being careful to enroll students admitted with distinction, those enrolled on a regular basis, and those admitted with warning in approximately the same proportions as they were included in the total population of freshman matriculates. Thus, as shown in Table 3, of the students enrolled in the modified course, nineteen (17 per cent) were admitted with distinction, eighty-six

\begin{table}
\centering
\caption{STUDENT SAMPLE ENROLLED IN GEOG 101 PHYSICAL GEOGRAPHY- EARTH SCIENCE MODIFIED COURSE, AUTUMN QUARTER, 1971}
\begin{tabular}{lrr}
\hline
Student Admission Classification & Number Enrolled & Per Cent Enrolled* \\
\hline
Students Admitted with Distinction & 19 & 17 \\
Regular Admission Students & 86 & 78 \\
Students Admitted with Warning & 5 & 5 \\
Total & 110 & 100 \\
\hline
\end{tabular}

*Percentages rounded to nearest whole per cent. Data include the number of students initially enrolled in the modified program.
\end{table}

\textsuperscript{106}Ball State University Catalog, \textit{op. cit.}, p. 11.
(78 per cent) were regularly admitted, and five (5 per cent) were admitted with warning.

Of the 110 students initially enrolled in the modified course, one-hundred completed the requirements. The ten students who did not complete the requirements included: 1) three students who never attended the class, 2) two students who were not matriculating freshmen, 3) one student who had not taken the SAT test, and 4) four students who did not complete all course requirements.

The one-hundred students who completed all course requirements represented a number of academic areas within the university. This is shown in Table 4.

**TABLE 4**

**DISTRIBUTION OF STUDENT SAMPLE BY MAJOR ACADEMIC AREA**

<table>
<thead>
<tr>
<th>Academic Area</th>
<th>Number Enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business, Business Education</td>
<td>9</td>
</tr>
<tr>
<td>Elementary Education</td>
<td>4</td>
</tr>
<tr>
<td>English, Journalism</td>
<td>8</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>1</td>
</tr>
<tr>
<td>History, Political Science, Social Work</td>
<td>12</td>
</tr>
<tr>
<td>Home Economics</td>
<td>4</td>
</tr>
<tr>
<td>Industrial Education</td>
<td>2</td>
</tr>
<tr>
<td>Marketing, Accounting</td>
<td>5</td>
</tr>
<tr>
<td>Music, Music Education</td>
<td>4</td>
</tr>
</tbody>
</table>
The Achievement Tests

Two groups of achievement tests were constructed for use in this research. The first group consisted of ten unit tests of approximately ten questions each, totaling 110 questions. These questions were based upon unit objectives. Each test comprised the pre- and post-test for the unit being studied. The pre-test was to provide a base score from which to measure student achievement gain. In all cases, the students took the pre-test upon entering the study carrel area and before beginning study of the unit. The unit assignment was then completed with the post-test following completion of this assignment. All pre- and post-test results were carefully recorded on a master list. All pre- and post-test records also were posted in the study carrel area in order that the students would be kept fully informed of their progress in the course.

The second group of tests was devised for use prior to and following completion of the modified independent study program.
This test contained fifty questions taken from the total 110 questions of the units into which the course material was divided. The results of this comprehensive pre- and post-test were useful as an indicator of student achievement in the modified course. The pre-test also provided the student with preliminary information concerning course content.

The questions developed to measure student achievement (both unit tests and the comprehensive test) were analyzed by performing an item and test analysis of results on both pre- and post-tests. Both discrimination and difficulty of each test item were determined, as well as the reliabilities of the combined unit tests and the comprehensive tests. For reliability determination, the Kuder-Richardson Formula 20 was utilized. These factors are further discussed in Chapter Four.

In the development of the 110 test items of the units, one of the goals was to include questions that developed critical thinking, that is, questions that involved thought processes beyond the memory level category.\textsuperscript{107} This involved assigning to each question some type of hierarchy of ranking according to the type of thinking required in answering the question. The method followed, as developed by Bloom\textsuperscript{108} and later adapted by Sanders,\textsuperscript{109} was to categorize questions, as follows:

\textsuperscript{107}Sanders, \textit{op. cit.}, p. 6.
\textsuperscript{108}Bloom, \textit{op. cit.}
\textsuperscript{109}Sanders, \textit{op. cit.}, pp. 1-176.
1. Memory: The student recalls or recognizes information.

2. Translation: The student changes information into a different symbolic form or language.

3. Interpretation: The student discovers relationships among facts, generalizations, definitions, values, and skills.

4. Application: The student solves a lifelike problem that requires the identification of the issue and the selection and use of appropriate generalizations and skills.

5. Analysis: The student solves a problem in the light of conscious knowledge of the parts and forms of thinking.

6. Synthesis: The student solves a problem that requires original, creative thinking.

7. Evaluation: The student makes a judgment of good or bad, right or wrong, according to standards he designates.\textsuperscript{110}

The investigator submitted the unit tests - the 110 questions - to a panel of specialists in test development (professors in educational psychology at Ball State University) for their evaluation. Each evaluator ranked the questions from one to

\textsuperscript{110}Ibid., p. 3.
seven according to the hierarchy described above. The evaluators worked independently without consulting with one another. The investigator also ranked the questions. The results of the evaluation were averaged, the resulting number becoming the ranking given to that question. An analysis of the ranking may be found in Chapter Four.

Although a good test will necessitate a variety of types of thinking, for this study the questions were designed to be applicable to the lower levels of memory, translation, interpretation, and application. In the opinion of the investigator’s committee chairman and of the panel of specialists such a procedure would prove more valid than if large numbers of higher level questions were used. The reason for this was that most freshman matriculatates have had considerable secondary school testing experience and would, therefore, more likely be familiar with the lower level processes of thinking than those of the higher levels.

The Attitude Scale

What changes in student attitudes toward science and scientists resulted due to taking the modified physical geography-earth science course? Would there be positive or negative changes in attitude? The answer to these questions were gained by administering an attitude scale at the beginning of the quarter and again during the last full week of classes before final examinations. Changes in attitude were noted and recorded. The scale used was that prepared by Cummings at The Ohio State
This attitude scale included sixty-seven items about science, scientists, and scientific careers. All items were stated as complete, single-thought statements. Some items were written as positive statements; others were written as negative statements. The student indicated his initial reaction to each item by selecting a value on a five-point scale. His reaction could vary from strong agreement to strong disagreement. In analyzing the answer sheets, numerical values were assigned to each response, as follows:

<table>
<thead>
<tr>
<th>Positive Statement</th>
<th>Student Reaction</th>
<th>Negative Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Strong agreement with item</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Agreement with item</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Neutral reaction to item</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Disagreement with item</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>Strong disagreement with item</td>
<td>5</td>
</tr>
</tbody>
</table>

This method provided a uniform numerical system in which each student's average attitude could be determined. The analysis of student change in attitude may be found in Chapter Four (see Appendix VI, also).

The Student Interviews

Thirty of the students completing the requirements of the modified physical geography-earth science course were randomly selected and asked to provide a subjective opinion concerning

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\[111\text{Cummings, op. cit.}\]
the program. This was accomplished through taped interviews administered in complete privacy. The students were asked to respond to three questions:

1. What three things about the modified program turned you on the most, and why?

2. What three things about the modified program turned you off the most, and why?

3. Please make any other comments you wish about the modified program.

Following the interviews, the major comments were categorized. These comments and several complete interviews may be found in Chapter Four.

**The Data Collection**

The data, collected during the Autumn quarter, 1971, included:

1. the results of ten pre- and post-tests concerning the content units.

2. test results from one fifty-question comprehensive pre- and post-test.

3. results from the pre- and post-course attitude scale.

4. results of post-course interviews.

5. a record of SAT-score data.

6. a record of high school graduating class percentile rank.

7. a record of the student's initial declaration of his
major academic area of study.

8. a record of the number of times and the amount of time spent at the study carrel.

**Treatment of the Data**

The hypotheses were based upon seven criteria, or variables, three of which were independent variables, and four of which were dependent variables. Independent variables included Scholastic Aptitude Test scores, high school graduating class percentile rank, and declaration of a major academic preparation area. Dependent variables included mean gain of achievement scores on combined unit tests and a comprehensive test, the amount of time spent at the study carrel, the number of times the study carrel was utilized, and change in attitude toward science and scientists (determined by use of a pre- and post-attitude scale) as a result of taking the course by the A-V-T teaching-learning method.

The upper and lower 27 per cent groups within each of the variables were matched with the appropriate mean gain of achievement scores on the aforementioned unit tests and the comprehensive test.

The data then were used in a pairwise-related $t$ test to determine if the students learned at significant levels by taking the modified physical geography-earth science course, and in an independent $t$ test to determine if the students learned the material differentially at significant levels.

Basically, a $t$ test may be used to determine just how great
two mean differences must be in order for the difference to be judged statistically significant; that is, a significant departure from differences which might be expected by chance alone. When using a t test, the null hypothesis is tested by asserting that two group means are not significantly different (as was stated in the six hypotheses), that the means are so similar that the sample groups may be considered to have been taken from the same population. 112

The computed t test values were compared with a probability table of t values to determine the level of significance of the hypotheses. Computed t values equal to or exceeding the table value of t, at the level of significance under consideration, resulted in rejection of the given hypotheses. Lower computed t values resulted in acceptance of the given hypotheses.

A Wang 700 series computer was used for testing of the hypotheses. Other data were analyzed by hand. Further explanation of the treated data may be found in Chapter Four.

Summary

A study carrel area was prepared for use by the student sample during the investigation. The physical facility was developed for the most efficient and effective use of the room.

The content of the units included materials which the

investigator believed would lead the student to a better understanding of and a greater appreciation for several elements of his environment, including the following:

1. the place of the earth in the solar system, including earth measurements and earth movements.

2. the relationships among temperature, pressure, winds, moisture, precipitation, and frontal systems in the development of the science called meteorology.

3. the place of maps and map interpretation in the study of physical geography and earth science, using topographic map interpretation as a case in point.

4. the importance of mineral and rock studies in physical geography and earth science as a preliminary exercise in the understanding of geology.

5. the significance of soil studies in the broad spectrum of physical geography and earth science.

6. the opening of new vistas for the student interested in physical geography and earth science.

These topics would not only be a valuable addition to their general education, but the investigator also believed the topics would be interesting to the students.

The laboratory investigations and other activities were selected on the bases that the students would be interested in them and would be able to complete them.

The student sample for this research was a stratified ran-
dom sample in which care was taken to enroll students admitted with distinction, those regularly admitted, and those admitted with warning in approximately the same proportions as they were included in the total population of freshman matriculates. Of the 110 students initially enrolled in the modified course, one-hundred completed all the course requirements.

Two groups of pre- and post-achievement tests were constructed for use in this research. One group consisted of unit tests of approximately ten questions each. The other, a comprehensive fifty-question test, was taken from the questions used in the unit tests. Item and test analyses were completed on all test questions. Further, the examination results were utilized in testing the hypotheses, through the use of two kinds of t-tests, to determine if the students learned the content material and if they learned the material differentially. The six hypotheses were related to student potential for academic success in college, and to behavior patterns in using the study carrels. Finally, all test items were submitted to a panel of specialists, which evaluated the thinking processes required in answering the questions.

The Cummings attitude scale was administered both at the beginning and near the end of the program to determine if there was a positive or negative change in student attitudes as a result of completing the modified course.

Taped interviews were completed with thirty randomly-
selected students taking part. An effort was made to obtain subjective opinions concerning the modified program.

Chapter Four will present an analysis of the data that were collected during the period of this research. This presentation will include discussions concerning achievement tests, testing of the hypotheses, the attitude scale, and student interviews.
were taken immediately following completion of appropriate assign-
ments. The comprehensive post-test was administered during the
last full week of classes during the quarter.

The questions developed to measure student achievement, on
both the unit and comprehensive tests, were analyzed by performing
an item and test analysis of the results. The test questions, and
ratings on difficulty and discrimination, may be found in Appen-
dix V. Kuder-Richardson Formula 20 post-test reliabilities were
found to be 0.88 and 0.77 on unit and comprehensive tests, re-
spectively.

Item difficulty is the percentage of students answering the
given item correctly. It is an inverse index in which larger num-
bers indicate the less difficult or easier items and smaller num-
bers the more difficult items. Although the recommendation is
made that the difficulty fall somewhere between 30 and 70 per
cent, for this study it was intended that the difficulty of the
majority of the questions would fall between 30 and 80 per cent
on post-tests. The higher figure was selected because it was
believed that both the poorer and the better students would do
better than usual because of the use of the A-V-T method. A
summary of item difficulty for the two groups of tests follows:

<table>
<thead>
<tr>
<th></th>
<th>Comprehensive test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Difficult</td>
<td>below 30 = 8 per cent of questions</td>
</tr>
<tr>
<td>Average Difficulty</td>
<td>30 - 80 = 60 per cent of questions</td>
</tr>
<tr>
<td>Least Difficult</td>
<td>above 80 = 32 per cent of questions</td>
</tr>
</tbody>
</table>
CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

Introduction

The purpose of this chapter is to present and analyze the data that were collected during the Autumn quarter, 1971. The material presented here will include a discussion of:

1. achievement tests.
   a. item and test analyses.
   b. hierarchy of questions.
2. the attitude scale.
3. testing of the hypotheses.
4. the student interviews.

The Achievement Tests

As previously mentioned, two groups of pre- and post-achievement tests were developed. These were made up of: 1) ten unit tests of approximately ten questions each, and 2) a comprehensive fifty-question test, taken from the questions of the unit tests.

The test questions were based upon unit objectives. Each unit pre-test and the comprehensive pre-test provided a base score from which to measure student achievement gain. Unit post-tests
Unit tests

Most Difficult below 30 = 3 per cent of questions
Average Difficulty 30 - 80 = 56 per cent of questions
Least Difficult above 80 = 41 per cent of questions

Item discrimination is the extent to which an item is answered correctly by the better or higher-scoring students and answered incorrectly by the poorer or lower-scoring students. The better and poorer student groups were found by taking the upper and lower 27 per cent of the total student group according to total test score. For this study it was intended that, on post-tests, the majority of questions would discriminate at the 0.20 level or higher. A summary of item discrimination for the two groups of tests follows:

Comprehensive test

Superior item 0.40 and higher = 20 per cent of questions
Satisfactory item 0.20 - 0.39 = 50 per cent of questions
Weak item 0.00 - 0.19 = 28 per cent of questions
Very Poor item below 0.00 = 2 per cent of questions

Unit tests

Superior item 0.40 and higher = 19 per cent of questions
Satisfactory item 0.20 - 0.39 = 40 per cent of questions
Weak item 0.00 - 0.19 = 39 per cent of questions
Very Poor item below 0.00 = 2 per cent of questions

A goal in the development of the 110 test items used in the ten unit tests was to include questions that involved thought pro-
cesses beyond the memory category. This involved assigning to each question some type of hierarchy of ranking according to the type of thinking required in answering the question. Sanders' adaptation of Bloom's technique was used to categorize the questions. The categories, repeated here for the convenience of the reader, were:

1. Memory: The student recalls or recognizes information.
2. Translation: The student changes information into a different symbolic form or language.
3. Interpretation: The student discovers relationships among facts, generalizations, definitions, values, and skills.
4. Application: The student solves a likely problem that requires the identification of the issue and the selection and use of appropriate generalizations and skills.
5. Analysis: The student solves a problem in the light of conscious knowledge of the parts and forms of thinking.
6. Synthesis: The student solves a problem that requires original, creative thinking.
7. Evaluation: The student makes a judgment of good or bad, right or wrong, according to standards he designates.
The 110 questions were submitted to a panel of specialists in test development for evaluation, in which they ranked the questions according to the hierarchy described above. The level of thinking applied to each question may be found in Appendix V. Table 5, below, reveals that, of the total 110 questions used on the unit tests, 22.7 per cent were at the memory level, followed in rank order of hierarchy, from lowest to highest, by translation - 24.5 per cent, interpretation - 46.4 per cent, application - 5.5 per cent, and analysis - 0.9 per cent.

**TABLE 5**

<table>
<thead>
<tr>
<th>Level of Thinking</th>
<th>Comprehensive Test</th>
<th>Unit Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Cent of Questions</td>
<td>Per Cent of Questions</td>
</tr>
<tr>
<td>1. Memory</td>
<td>40.0</td>
<td>22.7</td>
</tr>
<tr>
<td>2. Translation</td>
<td>18.0</td>
<td>24.5</td>
</tr>
<tr>
<td>3. Interpretation</td>
<td>32.0</td>
<td>46.4</td>
</tr>
<tr>
<td>4. Application</td>
<td>8.0</td>
<td>5.5</td>
</tr>
<tr>
<td>5. Analysis</td>
<td>2.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0 per cent</td>
<td>100.0 per cent</td>
</tr>
</tbody>
</table>

The table further shows that a higher percentage of comprehensive test questions were at the lower memory level of 40.0 per cent. This was believed to be a desirable situation because the comprehensive pre-test was administered during the "hectic" first week of school when the freshman matriculates in the student
sample were not yet truly oriented to the idea of attending college, let alone taking the A-V-T modified course.

The Attitude Scale

One of the goals of this research was to determine if student attitudes toward science and scientists would change as a result of taking the modified course. The attitude scale used was that prepared by Cummings at The Ohio State University (see Appendix VI). Although Cummings had developed this scale to measure the attitudes of students enrolled in elementary science methods courses, the items in this scale seemed appropriate for use in measuring student attitudes in the modified A-V-T program. The attitude scale included sixty-seven items about science, scientists, and scientific careers. The student indicated his initial reaction to each item by selecting a value on a five-point scale, his reaction varying from strong agreement through agreement, neutral reaction, disagreement, and strong disagreement.

The attitude scale was administered to the student sample during the first week of the course and again during the last full week of classes before final examinations. Following completion of the attitude scales, appropriate values (from 5 to 1) based upon student reaction were assigned to each response, and the results averaged. It was found that the direction of change in attitude toward science and scientists, from pre- to post-attitude scale, was positive for 64 per cent of the student sample, and negative for 36 per cent of the sample.
The results of student change in attitude toward science and scientists also were used in testing one of the hypotheses, as will be described below.

Testing of the Hypotheses

Before testing the major hypotheses through an independent t test, it was deemed advisable to determine if each of the groups, that is, the upper and lower 27 per cent groups of the student sample, had actually learned the content material at a statistically significant level. This was accomplished through the use of a pairwise-related t test, designed in such a manner that it would apply directly to each of the criteria stated in the major hypotheses. This type of test assumes a hypothesis which, if stated in null form, would indicate that the students would not learn, that is, the difference of the means of pre- and post-test scores of the groups involved would be zero.

An examination of Table 6 and Table 7 reveals that, on the fifty-question comprehensive test, both the upper and lower 27 per cent groups of the student sample did indeed learn the content at a statistically significant level. For all the criteria shown in the tables, the computed absolute values of t far exceeded the required t value.

Another criterion, that of declared and undeclared majors, was not a 27 per cent comparison. Rather, 63 per cent of the student sample had declared an academic major upon matriculation,
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>21.74</td>
<td>3.92</td>
<td>13.786*</td>
</tr>
<tr>
<td>Post-</td>
<td>37.37</td>
<td>4.97</td>
<td></td>
</tr>
<tr>
<td>High School Graduating Class Per-centile Rank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>20.67</td>
<td>4.09</td>
<td>14.669*</td>
</tr>
<tr>
<td>Post-</td>
<td>37.04</td>
<td>5.08</td>
<td></td>
</tr>
<tr>
<td>Time at Study Carrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>20.22</td>
<td>4.51</td>
<td>16.760*</td>
</tr>
<tr>
<td>Post-</td>
<td>35.26</td>
<td>4.70</td>
<td></td>
</tr>
<tr>
<td>Times at Study Carrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>20.22</td>
<td>3.89</td>
<td>12.652*</td>
</tr>
<tr>
<td>Post-</td>
<td>34.07</td>
<td>5.19</td>
<td></td>
</tr>
<tr>
<td>Attitude Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>20.00</td>
<td>4.39</td>
<td>12.974*</td>
</tr>
<tr>
<td>Post-</td>
<td>33.59</td>
<td>5.54</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .01 Level
Level of Significance = .01 = 2.78
for Two-Tailed Test
Degrees of Freedom = 26
TABLE 7
RELATIONSHIP OF HYPOTHESES CRITERIA AND COURSE ACHIEVEMENT
PAIRWISE-RELATED t TEST OF COMPREHENSIVE TEST
LOWER 27 PER CENT

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>17.93</td>
<td>3.96</td>
<td>13.640*</td>
</tr>
<tr>
<td>Post-</td>
<td>32.19</td>
<td>6.14</td>
<td></td>
</tr>
<tr>
<td>High School Graduating Class Percentile Rank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>19.93</td>
<td>4.30</td>
<td>11.571*</td>
</tr>
<tr>
<td>Post-</td>
<td>32.56</td>
<td>5.89</td>
<td></td>
</tr>
<tr>
<td>Time at Study Carrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>19.89</td>
<td>4.64</td>
<td>11.109*</td>
</tr>
<tr>
<td>Post-</td>
<td>32.67</td>
<td>6.75</td>
<td></td>
</tr>
<tr>
<td>Times at Study Carrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>20.51</td>
<td>4.78</td>
<td>12.034*</td>
</tr>
<tr>
<td>Post-</td>
<td>32.52</td>
<td>5.62</td>
<td></td>
</tr>
<tr>
<td>Attitude Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>20.52</td>
<td>4.45</td>
<td>11.604*</td>
</tr>
<tr>
<td>Post-</td>
<td>34.03</td>
<td>6.82</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .01 Level
Level of Significance - .01 = 2.78 for Two-Tailed Test
Degrees of Freedom = 26
whereas, 37 per cent had not. The pairwise-related t test results, as shown in Table 8, however, were similar to those found with the other criteria.

**TABLE 8**

**RELATIONSHIP OF DECLARED AND UNDECLARED MAJOR ACADEMIC AREAS AND COURSE ACHIEVEMENT**

**PAIRWISE-RELATED t TEST OF COMPREHENSIVE TEST**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared Major</td>
<td>Pre- 19.94</td>
<td>4.28</td>
<td>17.146*</td>
</tr>
<tr>
<td></td>
<td>Post- 34.22</td>
<td>5.58</td>
<td></td>
</tr>
<tr>
<td>Undeclared Major</td>
<td>Pre- 20.35</td>
<td>4.26</td>
<td>13.032*</td>
</tr>
<tr>
<td></td>
<td>Post- 34.24</td>
<td>6.35</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .01 Level

Level of Significance - .01 = 2.66 for Two-Tailed Test

Degrees of Freedom - Declared = 62, Undeclared = 36

An examination of Table 9 and Table 10 reveals further that, on unit tests, both the upper and lower 27 per cent groups of the student sample learned the content material at a statistically significant level. For all the criteria shown in the tables, the computed absolute values of t far exceeded the required t value.

As previously mentioned, the criterion of a declared or
TABLE 9

RELATIONSHIP OF HYPOTHESES CRITERIA
AND COURSE ACHIEVEMENT
PAIRWISE-RELATED t TEST OF TEN UNIT TESTS
UPPER 27 PER CENT

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>41.81</td>
<td>6.70</td>
<td>19.059*</td>
</tr>
<tr>
<td>Post-</td>
<td>79.00</td>
<td>8.37</td>
<td></td>
</tr>
<tr>
<td>High School Graduating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>39.26</td>
<td>5.53</td>
<td>20.687*</td>
</tr>
<tr>
<td>Post-</td>
<td>78.04</td>
<td>9.27</td>
<td></td>
</tr>
<tr>
<td>Class Percentile Rank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time at Study Carrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>37.41</td>
<td>6.01</td>
<td>22.099*</td>
</tr>
<tr>
<td>Post-</td>
<td>73.37</td>
<td>9.76</td>
<td></td>
</tr>
<tr>
<td>Times at Study Carrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>37.81</td>
<td>7.10</td>
<td>20.099*</td>
</tr>
<tr>
<td>Post-</td>
<td>72.89</td>
<td>10.68</td>
<td></td>
</tr>
<tr>
<td>Attitude Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>37.81</td>
<td>5.39</td>
<td>16.589*</td>
</tr>
<tr>
<td>Post-</td>
<td>69.81</td>
<td>9.68</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .01 Level
Level of Significance - .01 = 2.78
for Two-Tailed Test
Degrees of Freedom = 26
TABLE 10

RELATIONSHIP OF HYPOTHESES CRITERIA
AND COURSE ACHIEVEMENT
PAIRWISE-RELATED t TEST OF TEN UNIT TESTS
LOWER 27 PER CENT

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td>Pre- 35.26</td>
<td>5.89</td>
<td>16.748*</td>
</tr>
<tr>
<td></td>
<td>Post- 63.81</td>
<td>10.10</td>
<td></td>
</tr>
<tr>
<td>High School Graduating</td>
<td>Pre- 38.81</td>
<td>6.89</td>
<td>22.087*</td>
</tr>
<tr>
<td></td>
<td>Post- 69.22</td>
<td>9.21</td>
<td></td>
</tr>
<tr>
<td>Class Percentile Rank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time at Study Carrel</td>
<td>Pre- 39.52</td>
<td>7.27</td>
<td>14.705*</td>
</tr>
<tr>
<td></td>
<td>Post- 70.81</td>
<td>14.14</td>
<td></td>
</tr>
<tr>
<td>Times at Study Carrel</td>
<td>Pre- 40.19</td>
<td>5.51</td>
<td>18.004*</td>
</tr>
<tr>
<td></td>
<td>Post- 74.33</td>
<td>10.91</td>
<td></td>
</tr>
<tr>
<td>Attitude Gain</td>
<td>Pre- 38.66</td>
<td>7.79</td>
<td>15.770*</td>
</tr>
<tr>
<td></td>
<td>Post- 71.78</td>
<td>13.15</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .01 Level
Level of Significance - .01 = 2.78
for Two-Tailed Test
Degrees of Freedom = 26
undeclared major was not a 27 per cent comparison, but rather a comparison of 63 per cent declared major and 37 per cent undeclared major. The pairwise-related t test results, as shown in Table 11, were similar to those found with the other criteria.

**TABLE 11**

RELATIONSHIP OF DECLARED AND UNDECLARED MAJOR ACADEMIC AREAS AND COURSE ACHIEVEMENT

PAIRWISE-RELATED t TEST OF TEN UNIT TESTS

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Mean Pre</th>
<th>Mean Post</th>
<th>Standard Deviation</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared Major</td>
<td>37.89</td>
<td>71.54</td>
<td>6.67</td>
<td>25.072*</td>
</tr>
<tr>
<td>Undeclared Major</td>
<td>40.03</td>
<td>74.16</td>
<td>5.86</td>
<td>25.987*</td>
</tr>
</tbody>
</table>

*Significant at .01 Level
Level of Significance = .01 = 2.66 for Two-Tailed Test
Degrees of Freedom - Declared = 62, Undeclared = 36

After the preliminary determinations noted above, the major hypotheses were tested. In the descriptions of each of these tests which follow, the null hypothesis will be restated and the results or findings will be noted immediately below.
TABLE 12

RELATIONSHIP OF HYPOTHESES CRITERIA AND COURSE ACHIEVEMENT
INDEPENDENT t TEST OF COMPREHENSIVE TEST

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Upper 27 Per Cent</th>
<th></th>
<th>Lower 27 Per Cent</th>
<th></th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Gain</td>
<td>Standard Deviation</td>
<td>Mean Gain</td>
<td>Standard Deviation</td>
<td></td>
</tr>
<tr>
<td>SAT</td>
<td>15.63</td>
<td>5.89</td>
<td>14.26</td>
<td>5.43</td>
<td>.889</td>
</tr>
<tr>
<td>High School Graduating Class Per-</td>
<td>16.37</td>
<td>5.80</td>
<td>12.63</td>
<td>5.69</td>
<td>2.397*</td>
</tr>
<tr>
<td>centile Rank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time at Study Carrel</td>
<td>15.04</td>
<td>4.72</td>
<td>12.78</td>
<td>5.98</td>
<td>1.542</td>
</tr>
<tr>
<td>Times at Study Carrel</td>
<td>13.85</td>
<td>5.69</td>
<td>12.00</td>
<td>5.18</td>
<td>1.250</td>
</tr>
<tr>
<td>Attitude Gain</td>
<td>13.59</td>
<td>5.44</td>
<td>13.51</td>
<td>6.05</td>
<td>.473</td>
</tr>
</tbody>
</table>

*Significant at .05 Level
Level of Significance - .05 = 2.01, .01 = 2.68
for Two-Tailed Test
Degrees of Freedom = 52
Major Hypothesis 1

No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample with the highest total Scholastic Aptitude Test (SAT) scores and the 27 per cent with the lowest total SAT scores.

a. An examination of Table 12 reveals that, on the fifty-question comprehensive test, with a computed absolute t value of .889, the data supported the null hypothesis. That is, there was no statistically significant difference found between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to the SAT criterion.

b. An examination of Table 13 reveals that, on unit tests, with a computed absolute t value of 3.331, the data did not support the null hypothesis. This finding, in fact, indicated that there was a statistically significant difference at the .01 level of significance. Further interpretation of this criterion will be discussed below.

Major Hypothesis 2

No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample with the highest percentile rank in their high school graduating class and the 27 per cent with the lowest percentile rank in their high school graduating class.

a. An examination of Table 12 reveals that, on the fifty-question comprehensive test, with a computed absolute t value of 2.397, the data did not support the null hypo-
TABLE 13

RELATIONSHIP OF HYPOTHESES CRITERIA AND COURSE ACHIEVEMENT
INDEPENDENT t TEST OF TEN UNIT TESTS

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Upper 27 Per Cent</th>
<th>Lower 27 Per Cent</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Gain</td>
<td>Standard Deviation</td>
<td>Mean Gain</td>
</tr>
<tr>
<td>SAT</td>
<td>37.19</td>
<td>9.85</td>
<td>28.56</td>
</tr>
<tr>
<td>High School Graduating Class Percentile Rank</td>
<td>38.78</td>
<td>9.54</td>
<td>30.00</td>
</tr>
<tr>
<td>Time at Study Carrel</td>
<td>35.96</td>
<td>8.37</td>
<td>31.29</td>
</tr>
<tr>
<td>Times at Study Carrel</td>
<td>35.07</td>
<td>9.07</td>
<td>34.14</td>
</tr>
<tr>
<td>Attitude Gain</td>
<td>32.00</td>
<td>10.02</td>
<td>33.11</td>
</tr>
</tbody>
</table>

*Significant at .01 Level

Level of Significance \( .05 = 2.01, .01 = 2.68 \)

for Two-Tailed Test

Degrees of Freedom = 52
thesis at the .05 level, but did support the hypothesis at the .01 level of significance. Thus, there was a statistically significant difference found between the mean gain of achievement scores gained by the upper and lower 27 per cent groups with respect to high school graduating class percentile rank at the .05 level of significance. Further discussion of this finding may be found below.

b. An examination of Table 13 reveals that, on unit tests, with a computed absolute t value of 3.599, the data did not support the null hypothesis. That is, there was a statistically significant difference between the mean gain of achievement scores attained by the upper and lower 27 per cent groups at the .01 level of significance with respect to high school graduating class percentile rank. This factor also will be further discussed below.

Major Hypothesis 3

No statistically significant differences will exist between the mean gain of achievement scores attained by those who declared a major academic preparation area upon matriculation and those who did not declare a major academic preparation area upon matriculation.

a. An examination of Table 14 reveals that, on the fifty-question comprehensive test, with a computed absolute t value of .336, the data supported the null hypothesis. That is, there was no statistically significant differ-
ence between the mean gain of achievement scores attained by those students who declared a major academic preparation area upon matriculation, and those who did not.

**TABLE 14**

<table>
<thead>
<tr>
<th>Declared Major</th>
<th>Undeclared Major</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Gain</td>
<td>Standard Deviation</td>
<td>Mean Gain</td>
</tr>
<tr>
<td>14.29</td>
<td>5.08</td>
<td>13.89</td>
</tr>
</tbody>
</table>

Level of Significance - .05 = 1.99, .01 = 2.63 for Two-Tailed Test

Degrees of Freedom = 98

b. An examination of Table 15 reveals that, on unit tests, with a computed absolute t value of .240, the data supported the null hypothesis. Thus, there was no statistically significant difference between the mean gain of achievement scores attained by those students who declared a major academic preparation area upon matriculation, and those who did not.
TABLE 15
RELATIONSHIP OF DECLARED AND UNDECLARED MAJOR ACADEMIC AREAS
AND COURSE ACHIEVEMENT
INDEPENDENT t TEST OF TEN UNIT TESTS

<table>
<thead>
<tr>
<th>Declared Major Mean Gain</th>
<th>Undeclared Major Mean Gain</th>
<th>Computed Absolute Value of t</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.65</td>
<td>34.14</td>
<td>10.65</td>
</tr>
<tr>
<td>10.65</td>
<td>7.99</td>
<td>.240</td>
</tr>
</tbody>
</table>

Level of Significance - .05 = 1.99, .01 = 2.63
for Two-Tailed Test
Degrees of Freedom = 98

Major Hypothesis 1
No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample which spends the greatest amount of time using the study carrels and the 27 per cent which spends the least amount of time using the study carrels.

a. An examination of Table 12 reveals that, on the fifty-question comprehensive test, with a computed absolute t value of 1.542, the data supported the null hypothesis. There thus was no statistically significant difference between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to the criterion related to the amount of time spent at the study carrels.

b. An examination of Table 13 reveals that, on unit tests, with a computed absolute t value of 1.742, the data supported the null hypothesis. That is, there was no
statistically significant difference found between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to this hypothesis criterion.

**Major Hypothesis 5**

No statistically significant differences will exist between the mean gain of achievement scores attained by the 27 per cent of the student sample which spends the greatest number of times using the study carrels and the 27 per cent which spends the least number of times using the study carrels.

a. An examination of Table 12 reveals that, on the fifty-question comprehensive test, with a computed absolute t value of 1.250, the data supported the null hypothesis. That is, there was no statistically significant difference found between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to the criterion related to the number of times spent at the study carrels.

b. An examination of Table 13 reveals that, on unit tests, with a computed absolute t value of .359, the data supported the null hypothesis. There thus was no statistically significant difference found between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to this hypothesis criterion.

**Major Hypothesis 6**

No statistically significant differences will exist between
the mean gain of achievement scores attained by the 27 per cent of the student sample with the greatest gain in positive attitude toward science and the scientist and the 27 per cent with the least positive gain in attitude.

a. An examination of Table 12 reveals that, on the fifty-question comprehensive test, with a computed absolute t value of .173, the data supported the null hypothesis. That is, there was no statistically significant difference found between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to this hypothesis criterion of attitude.

b. An examination of Table 13 reveals that, on unit tests, with a computed absolute t value of .390, the null hypothesis was supported by the data. That is, there was no statistically significant difference found between the mean gain of achievement scores attained by the upper and lower 27 per cent groups with respect to this hypothesis criterion of attitude.

An Interpretation of the Findings

An examination of the findings reveals that, in general, the students learned the content material at statistically significant levels, but did not learn differentially with respect to the upper and lower 27 per cent groups being tested. There were, however, several instances in which differential learning was noted. These cases will be discussed below.

Further examination of Table 13, which refers to the unit
tests, reveals that the data did not support the null hypotheses concerned with SAT scores and high school graduating class percentile rank. That is, the upper and lower 27 per cent groups of the student sample did indeed learn differentially with respect to those criteria. On the other criteria, however, the data supported the null hypotheses. Why should this be so? It appeared to the investigator that the SAT scores and high school graduating class percentile rank reflected academic ability. SAT scores measure verbal and quantitative achievement and are used as a predictor of potential academic college success. High school graduating class percentile rank is a measure of a student's past academic success. These two kinds of achievement scores, then, are concerned with academic ability. It thus appeared that, with respect to these two criteria, the two groups in the student sample would be expected to learn differentially to a statistically significant degree. The other criteria, related to different student behaviors or study habits during the period of the research, would not necessarily and did not, however, result in differential learning to a statistically significant degree.

Further examination of Table 12, which concerned the fifty-question comprehensive test, shows that the data supported all of the null hypotheses except for the criterion of high school graduating class percentile rank. In this case, the data did not support the null hypothesis at the .05 level of significance (although the hypothesis was supported at the .01 level). Again,
the question arises as to why this should be so. The investigator believed that this finding must be regarded as a chance occurrence or, again, that it may have been the result of academic ability as described above.

An additional concern was the comparison of the t test findings of Tables 12 and 13. Why would not all of the null hypotheses be supported in the same manner on both the comprehensive and the unit tests? It was believed that the time period involved between taking the pre- and post-tests in the two cases would, at least in part, account for the different findings. The time period between the pre- and post-comprehensive tests was approximately nine weeks. Pre- and post-unit tests, however, were usually administered within the same one hour period. The longer period of time between the pre- and post-comprehensive tests would possibly tend to equalize test results.

It should be mentioned that an examination of the item and test analysis, provided by the Office of Examination Services at Ball State University, reveals a possible final reason that the null hypotheses could be supported. The test analysis revealed that the upper and lower 27 per cent groups of the student sample achieved similar mean gain scores on unit and comprehensive tests. For example, on the comprehensive test, the upper 27 per cent group scored 24.41 on the pre-test, and 40.85 on the post-test, a gain of 16.44. The lower 27 per cent earned a mean score of 13.93 on the pre-test, and 25.92 on the post-test, a gain of 11.99. The
poorer students, then, gained in achievement at a rate similar to the better students, but began at a lower point on the scale. Similar achievement gains were noted between the upper and lower 27 per cent groups of the student sample on the unit tests, as well.

The Student Interviews

Thirty randomly-selected students who had completed the experimental program were interviewed in an effort to obtain their personal views concerning the A-V-T teaching-learning program. Audio-tape players were used for the interviews which were administered in complete privacy during the last week of the course.

The students were asked to respond to three questions. These were:

1. What three things about the modified program "turned you on" the most, and why?
2. What three things about the modified program "turned you off" the most, and why?
3. Please make any other comments you wish about the modified program.

Although the students did not appear to provide adequate answers as to why they liked or disliked the program, several comments, both favorable and unfavorable, were considered of sufficient interest to be reported in this research. Favorable comments included:

1. I liked being able to work at my own pace.
2. I liked having some choice in scheduling my carrel study time.

3. I liked the independence and responsibility of teaching myself.

4. I liked the experiments.

5. I liked the variety; so different from high school.

6. I liked being able to turn the tape back and listening to information more than once.

7. I liked being able to take advantage of the extra-study time in the evening.

8. I liked the post-tests being given after each unit rather than after completion of several units.

9. I liked the pre-tests. They provided some idea of what would be covered in the unit.

10. I liked the informality of the program.

Unfavorable comments included:

1. The laboratory assistants did not seem to want to help or answer questions.

2. The course content was not varied enough.

3. There was not enough homework.

4. There were not enough study times assigned.

5. Questions could not be asked of the tape player.

6. There was too much confusion at first.

7. The "good" times were already scheduled by the time I was to select my study carrel times.
8. There was no textbook.

A selected group of the taped interviews follow below in order that the reader may be more fully informed of student reaction to the modified program. They include both favorable and unfavorable comments.

Interview 1

The three things I liked about the program best: First of all, I liked the small amount of outside work. For some reason, it made me more eager to come to class, and to learn things because I wasn't bogged down with stuff during the week. The second thing I liked was being able to learn at my own speed and by myself. For example, if I missed something, I could always turn back and hear it again and it helped me to understand things more by being able to do this. The third thing I liked was being able to take the pre-test before we learned the assignment and before we took the post-test. This pre-test gave you some idea of what you would be learning, and taking the post-test immediately after you learned, it was better than waiting awhile, because the things were fresh in your mind and you remembered them better.

There weren't three things that I didn't like about it. The only thing that I missed was making new friends in college because I like to meet and talk to people. In this program, it was kind of impersonal because you came to class and you learned on your own, and didn't really meet a lot of people.

I hope in future years this program will be accepted at Ball State, not only in science but in other areas because it is a good one. It makes people more appreciative, I guess, of their own work. For some reason I felt that way. I really liked it a lot—that is all I have to say.

Interview 2

The three things that turned me on the most about the program is the freedom you have to choose your own time to come to start off. We were to come whenever it was the most convenient for us which was really nice. It didn't foul up your schedule. I liked the grading. You knew what to look for when you went into the unit because of the pre-test. Then, when you took the post-test, it was so much easier than the other courses. You knew the type of questions you were
going to be asked and you weren't totally unprepared as to how the Prof asked the questions.

The only thing I didn't like was that if you did have a question, you couldn't ask the tape—you didn't have anyone to turn to. Sometimes the lab assistants didn't always know and it was kind of difficult. But in the end they were always answered and it wasn't that bad.

I really enjoyed this course. It was something different. Since I am a first-quarter freshman, it was really great coming into a class like this—it was so different from high school. They were always the same old courses where you had to sit there and listen to your teacher, read the chapter, just do the assignments. This program was really great! I want to thank you. I really enjoyed this course!

Interview 3

One of the first things that I'd like to talk about that really turned me on, so to speak, was the fact that we could listen to the tape and if we didn't catch a point, we could just push the rewind button again and again until we got it. I was glad there was a room supervisor there to answer questions if we didn't get what was on the tape. Another thing I liked about the course was that it was presented in a practical manner. I liked that as far as the experiments and exercises were concerned, everything we did seemed to have a purpose. It gave me an appreciation for science. There weren't any ridiculous or silly things to do, or any "Mickey Mouse" stuff.

Things that bothered me about the course were that I felt that there was too much time elapsing between my study times. Sometimes, it seemed like the material was not covered in an orderly pattern and just skipped around. Then, I didn't feel like I was retaining very much of the material. I might have retained a little bit more if I had been scheduled more often during the week. Or, if I had had assignments outside of class, it might have been better. I would like to have had more experiments.

Overall, this was an interesting program to go through. I'd never had an experimental type class like this before. I guess only time will tell whether or not I have retained any of this or not as compared to a regular class situation.

Interview 4

Three things that turned me on about the program: I am
very in agreement with the idea of individualism. The fact that you're in your own booths so you don't have to look around and stare at three or five hundred other kids doing the same thing you are. I liked the fact that just using the tape was more interesting than listening to a regular lecture. Also, using a tape you could go at your own speed. You could thus, if you missed something, sort out the problem immediately and not wait until the next class. You didn't have to wait an hour and maybe pick it up from somebody else. You had it right in front of you. I think that is an excellent idea in itself. We skipped a whole bunch of fuddy-duddy of using a textbook which doesn't help that much.

Okay, now for the bad part. Are you ready? Don't flunk me. Three things that turned me off: I would have liked to study oceanography a little bit. And covered a little bit more in the world science-type situation. The experiments in class, part of them got to me because I think we have definitely proven that freshmen cannot pour water. This is one-excellent result of this situation. Other than that I could not think of anything that bothered me.

The program was interesting and I do believe quite beneficial. Having the grades available to us for keeping track of our progress was good. The program wasn't boring at all, I can say that. The first day or two were kind of hectic, but that was understandable because everything was so new to us.

Interview 5

I liked the way the program gave you variation through labs., lectures, slides, etc. It kept you moving and busy. That about sizes it up. I liked it very well. I thought it was very practical and I feel that I've learned alot more than I would have just sitting in on a lecture. I think we covered as much as the other classes did, so I don't feel like I have lost a thing. I have learned alot of things that will stick with me better since I learned them in practice and not just on theory and out of a book.

The only thing I didn't like about it was primarily my fault. I work kind of slowly, and many times I was cramped to complete the work in the given hour. I'm not sure that I am up to it, but I am going to have to learn to work faster.

Other than that, I really liked the class and I'd like to see other kids get a chance at it, too.
Summary

Two groups of pre- and post-achievement tests were developed. These consisted of: 1) ten unit tests of approximately ten questions each, and 2) a fifty-question comprehensive test taken from the questions of the unit tests.

An item and test analysis was performed on the two groups of tests. Item difficulty, item discrimination, and test reliabilities were determined.

Sanders' adaptation of Bloom's technique was utilized in assigning to each question a hierarchy of ranking according to the thought processes involved. It was found that the majority of questions, in fact, were at a ranking beyond the memory level.

The Cummings attitude scale revealed that the direction of change in attitude toward science and scientists, from pre- to post-attitude scale, was positive for 64 per cent of the student sample, and negative for 36 per cent of the sample.

The data collected during the period of the research were submitted to two kinds of testing. These were: 1) use of a pairwise-related t test to determine if the upper and lower 27 per cent of the students, according to several criteria, learned at statistically significant levels, and 2) an independent t test to determine if the upper and lower 27 per cent of the students, according to several criteria, learned differentially at statistically significant levels. The criteria under consideration in both types of t tests included SAT scores, high school graduating
class percentile rank, time at the study carrel, times at the study carrel, attitude gain, and declaration of an academic major preparation area (this last criterion was not a 27 per cent comparison). It was found that the students did indeed learn the content material at statistically significant levels with respect to all the criteria being considered. Further, the upper and lower 27 per cent groups learned differentially with respect to some criteria, and at statistically significant levels, but not with respect to other criteria. For example, in this research, SAT scores and high school graduating class percentile rank were considered good indicators of differential academic success; student behavior, study habits, and attitude change were not.

Audio-taped interviews with thirty randomly-selected students who had completed the modified program, revealed that students generally liked taking the course by the A-V-T teaching-learning method. High-priority likes of the students were: being able to work at their own pace, self-scheduling, independence and self-responsibility, and the variety of activities in the program. Some unfavorable comments centered on apparent lack of adequate help from graduate student assistants, insufficient study carrel time, and too much confusion in earlier parts of the program.

In Chapter Five, the reader will find a summary of the research completed concerning the physical geography-earth science A-V-T program at Ball State University during the Autumn quarter, 1971. This summary will be followed by the conclusions that were
made as a result of the findings of the research, as well as recommendations for further study.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The general purpose of this study was to determine certain of the effects and results of teaching the course, Fundamentals of Physical Geography and Earth Science, to matriculating freshmen at Ball State University by a modified independent study method. The modified course involved audio-visual-tutorial instruction wherein the students completed all course requirements at a study carrel or its immediate vicinity.

A study carrel area was prepared for use by the student sample during the period of the research. Each study carrel was equipped with an audio-tape player and headset, a slide projector and small screen, a small globe, a carrel notebook containing sketches and other materials to supplement the tape cassette lectures, and other teaching-learning materials as needed.

Each of the students selected two hours per week during which a study carrel was reserved for his use. At these, and occasionally at other times, if he felt the need, the student completed the assignments, including pre- and post-tests, laboratory investigations, listening to the audio-tapes, and other activities.

The content material of the modified course included segments on
the solar system, meteorology, topographic map interpretation, minerals and rocks, soils, and a brief discussion of other topics of general interest to physical geographers and earth scientists.

Two groups of pre- and post-achievement tests were developed for use by the 110 students who were initially enrolled in the modified course. These groups included ten unit tests and a comprehensive test. Unit tests were administered at the beginning and completion of each unit assignment. The comprehensive test was given at the beginning of the course and upon completion of course requirements.

Six major hypotheses were devised which were related to the students' mean gain of achievement scores on the tests. The criteria that were tested included Scholastic Aptitude Test scores, high school graduating class percentile rank, amount of time spent at the study carrel, number of times the study carrel was used, declaration of major academic preparation area, and attitude change resulting from taking the modified course.

The hypotheses were tested in two ways: 1) a pairwise-related t test was used to determine if the students learned at significant levels, and 2) an independent t test was used to determine if the upper and lower 27 per cent groups of the student sample learned differentially at significant levels.

It was found that the students did learn the content material at statistically significant levels with respect to all the criteria being considered. The upper and lower 27 per cent groups of
the student sample, furthermore, learned differentially at statistically significant levels, with respect to Scholastic Aptitude Test scores and high school graduating class percentile rank. They did not, however, learn differentially at statistically significant levels with respect to the other criteria being tested.

Audio-taped interviews with thirty randomly-selected students, who had completed the modified program, revealed that the students generally liked the A-V-T method. They particularly approved of the fact that they were responsible for their own learning, were able to work at their own pace, and that a variety of activities were included in the program.

Conclusions

Based upon achievement test results, testing of the hypotheses, student interviews, and the personal observations of the investigator during the period of this research, the following conclusions were made:

1. The A-V-T teaching-learning method may successfully be used in teaching a basic physical geography-earth science course. This conclusion is based upon the results obtained from using a pairwise-related t test on unit and comprehensive test scores which showed that the students in the sample learned at the .01 level of significance, with respect to all criteria tested in the hypotheses.

2. Scholastic Aptitude Test scores may be considered a good
indicator of differential academic success. This conclusion is based upon the results obtained from using an independent t test on unit test scores which showed that the upper and lower 27 per cent groups learned differentially at the .01 level of significance.

3. High school graduating class percentile rank may be considered a good indicator of differential academic success. This conclusion is based upon the results obtained from using an independent t test on unit and comprehensive test scores which showed that the upper and lower 27 per cent groups learned differentially on unit tests at the .01 level of significance, and on the comprehensive test at the .05 level of significance.

4. Student study habits and attitude change toward science and scientists may not be considered good indicators of differential academic success. This conclusion is based upon the results obtained from use of an independent t test on unit and comprehensive test scores which showed that the upper and lower 27 per cent groups of the student sample did not learn differentially at the .01 or .05 levels of significance.

5. The fact that students declare or do not declare a major academic preparation area upon matriculation may not be considered a good indicator of differential aca-
ademic success. This conclusion is based upon the results obtained from using an independent t test on unit and comprehensive test scores which showed that these two groups did not learn differentially at the .01 or .05 levels of significance.

6. The majority of students may be expected to record an attitude change toward science and scientists in a positive direction as a result of taking a basic physical geography-earth science course by A-V-T methods. This conclusion is based upon the fact that 64 per cent of the students in the sample recorded a positive change in attitude, based upon pre- and post-attitude test results, using the Cummings attitude scale, a scale used for determining attitude changes toward science and scientists.

7. In general, students will respond positively to the use of A-V-T teaching-learning methods in basic science courses. This conclusion is based upon the results obtained from interviewing thirty randomly-selected students who completed the modified course.

8. The use of A-V-T teaching-learning materials can be relatively inexpensive in teaching a total course by the A-V-T method. This conclusion is based upon the fact that, for this research, the cost of equipping each study booth was less than $200.00.
Recommendations

The period of research for this study, and the results obtained, led to several recommendations. These included:

1. Future evaluative studies in the education field should provide some explanation of the statistical devices used in the research. Even a cursory examination of basic statistics books indicates that many of these books were written because the authors realized that few educators truly understand the use and interpretation of statistical treatments of data. Popham summed up this idea when he stated:

This book was written primarily in reaction against my own experience as a student in educational statistics classes. It was evident that many of my fellow students in those classes were essentially going through the motions necessary to pass the course but were acquiring little real understanding of the statistical concepts which were treated. Subsequent conversations with numerous educators from all parts of the country confirmed my opinion that only a small collection of professional educators possess real confidence regarding their ability to use and interpret statistical methods. In the field of education, which, fortunately, is increasingly relying upon empirical research findings to guide the decision makers, such deficiencies in statistical understanding are disturbing.\textsuperscript{113}

The investigator makes the plea that a brief synopsis of the statistical device being used would greatly help the reader in more fully understanding the problem being analyzed.

\textsuperscript{113}Tbid., p. ix.
2. Surveys need to be made, and continuously updated, which explain and compare the various kinds of multimedia communications systems that are available for possible uses in teaching-learning situations. In this research it was found that the objectives of the modified program could be accomplished with relatively unsophisticated and inexpensive equipment. This finding might be of considerable value to someone wanting to work with A-V-T materials in the future.

3. More evaluative studies need to be made concerning A-V-T teaching-learning methods and the affective domain. For example, which kinds of behavioral changes may result when different types of A-V-T materials are used?

4. This study was confined to measurement of several differences within a student sample. It should prove worthwhile to make other comparisons within a student sample, and to compare an experimental group with a control group, using a treatment similar to the one used in this study.

5. Comparisons should be made between different "kinds" of student samples. While this study was confined to freshman matriculates, studies should be made of A-V-T instruction with other groups, such as upper classmen and delayed admissions students.
6. Studies should be made of the A-V-T method used in this research, but at different times of the year. Would A-V-T methods be valuable in fighting the "winter quarter blahs" syndrome?

7. Further studies should be made concerning the values of individualized study, per se. How does this kind of study really affect the student involved with this teaching method?

8. A logical next step following this research, where the total course was taught by A-V-T methods using audio-tape players, headsets, slide projectors, etc., would be to evaluate a multimedia program where the total course was taught by television video-taped lecture-demonstration-investigation methods.
APPENDIX I

CONTENT, OBJECTIVES, ACTIVITIES, AND MATERIALS OF ALL UNITS
Unit One  Earth Measurements

Content: This unit includes an audio-taped lecture and laboratory work concerning the shape of the earth, the size of the earth, and how one may locate himself (or any object) on the earth surface (the importance of the grid system and latitude and longitude).

Objectives: Upon completion of this unit, the student should be able to:

1. describe the size and shape of the earth,
2. use linear and angular measurements in establishing location on the earth surface, and
3. identify and describe the difference between great and small circles on the globe.

Activities: 1. Pre-test, Unit One
2. Examination of slides
   a. Salt flat in western United States
   b. Four slides concerned with latitude and longitude
3. Examination of Apollo 8 and Apollo 9 photographs
4. Examination of sketches in Carrel Notebook
   p. 1 Oblate spheroid shape of the earth
   p. 2 Ship disappearing from shore at about eighteen miles
   p. 3 Eratosthenes' measurement of earth circumference
5. Completion of Exercise 1, Earth Science Manual
6. Use of a globe to demonstrate latitude and longitude
7. Use of globe and rubber band to demonstrate great and small circles
8. Post-test, Unit One

Materials:
1. 6-inch Replogle Globe
2. Slides
   a. Salt flat in western United States
   b. Parallels and latitude
   c. Meridians and longitude
   d. Latitude and longitude on rectangular grid system
   e. Latitude and longitude on globes, spheres, and world rectangular projection
3. Carrel Notebook (Appendix III)
   p. 1 Earth Shape - Oblate Spheroid (exaggerated view)
   p. 2 Effect of Earth Curvature on Ship Disappearing from Shore at about eighteen miles
   p. 3 Eratosthenes' Measurement of Circumference of Earth
4. Apollo 8 and Apollo 9 photographs
5. Rubber band
6. Earth Science Manual, Exercise 1
7. Tape Cassette Lecture, Unit One, Earth Measurements

8. Pre- and post-tests, Unit One (Appendix V)

Unit Two Earth Movements

Content: This unit includes three audio-taped lectures, and laboratory work concerning movements of the earth in the solar system, including the relationships between rotation and revolution, altitude of the sun and latitude, and time and longitude determinations.

Objectives: Upon completion of this unit, the student should be able to:

1. describe earth rotation and revolution, including:
   a. definitions of rotation and revolution,
   b. periods of rotation and revolution,
   c. direction of rotation and revolution, and
   d. definition of plane of the ecliptic,

2. label sketches, indicating earth rotation and revolution,

3. identify causes of the seasons,

4. identify and label sketches of earth-sun relationships of the first day of any of the four seasons,

5. describe the general direction of sunrise and sunset for an observer on any given day of the year,
6. work altitude of the sun determinations and latitude determinations when given the altitude of the sun, and

7. work time and longitude determinations.

Activities: 1. Pre-test, Unit Two

2. Examination of motorized Trippensee Planetarium in operation


4. Examination of sketch in Carrel Notebook

   p. 4 Concentration of sun rays at different latitudes

5. Determination of altitude of sun model in study room, using ESCP Astrolabe


11. Post-test, Unit Two

Materials: 1. Motorized Trippensee Planetarium

2. Carrel Notebook

   p. 4 Concentration of sun rays at different latitudes
3. ESCP Astrolabe

4. Earth Science Manual, Exercises 2, 3, and 4

5. Tape Cassette Lecture, Unit Two, part one, Earth Movements - Rotation, Revolution, and Seasons

6. Tape Cassette Lecture, Unit Two, part two, Earth Movements - Altitude of the Sun and Latitude

7. Tape Cassette Lecture, Unit Two, part three - Earth Movements - Time and Longitude

8. Pre- and post-tests, Unit Two

Unit Three  Meteorology - Energy and Air Motion

Content: This unit includes two audio-taped lectures and laboratory work concerning Meteorology - Energy and Air Motion, including radiation, convection, and conduction, temperature, pressure, wind relationships, and effects of differential heating and cooling of land and water upon general air circulation.

Objectives: Upon completion of this unit, the student should be able to:

1. provide an explanation of the radiative balance of the earth and the energy budget,
2. describe the heating processes of radiation, convection, and conduction,
3. account for the different rates at which energy is absorbed by land and water,
4. explain how the spherical shape of the earth and its rotation help determine the distribution of incoming radiation,

5. describe Coriolis Effect,

6. explain the relationships between temperature and pressure as they relate to wind patterns, and

7. recognize the use of several weather instruments.

Activities:

1. Pre-test, Unit Three

2. Completion of radiant energy investigation

3. Examination of sketches in Carrel Notebook
   a. p. 4 Concentration of sun rays at different latitudes
   b. p. 5 Convection
   c. p. 6 Constructing a mercurial barometer
   d. p. 7 World Wind Belts
   e. p. 8 Sea Breezes - Land Breezes
   f. p. 9 Valley Breezes - Mountain Breezes
   g. p. 10 Pressure Cells

4. Examination of four slides of weather instruments

5. Examination of globe for land-water distribution discussion

6. Measurement of wind direction and velocity of fan-produced "wind" in study room, using portable wind-measuring device

7. Post-test, Unit Three
Materials: 1. Radiation Kit - ESCP
   a. 1 black cup
   b. 1 silver cup
   c. 2 Centigrade (Celsius) thermometers with styrofoam inserts for securing thermometers into cups
   d. 150-watt lamp and support
2. Instruction sheet for radiation investigation
3. Slides
   a. Weather instrument shelter
   b. Maximum and minimum thermometers, psychrometer
   c. Wind vanes and anemometers
   d. Mercurial and aneroid barometers
4. Belfort portable wind measuring set #6052
5. Ten-inch electric fan
6. Instruction sheet for wind measurement investigation
7. Tape Cassette Lecture, Unit Three, part one, Meteorology - Energy and Air Motion - Heating and Weather Instruments
8. Tape Cassette Lecture, Unit Three, part two, Meteorology - Energy and Air Motion - Differential Heating, Winds, and Pressure Cells
9. Pre- and post-tests, Unit Three
Content: This unit includes two audio-taped lectures and laboratory work concerning Meteorology - Water in the Air, including the water cycle, clouds and precipitation, air masses, weather fronts, anticyclones, and reading the daily weather map.

Objectives: Upon completion of this unit, the student should be able to:

1. explain how the atmosphere participates in the hydrologic cycle through evaporation, transpiration, sublimation, condensation, and precipitation of water,

2. describe and demonstrate the process of evaporation,

3. describe the process of condensation,

4. distinguish among and be able to identify a number of cloud types (using slides), according to National Weather Service descriptions,

5. demonstrate relative humidity determination,

6. describe air mass formation,

7. identify cyclones and anticyclones and the several types of frontal systems, and

8. plot and analyze weather data on weather maps, given appropriate encoding–decoding data and tables.
Activities:
1. Pre-test, Unit Four, part one
2. Evaporation investigation
3. Relative humidity determination investigation
4. Examination of thirty-two cloud slides
5. Post test, Unit Four, part one
6. Pre-test, Unit Four, part two
7. Examination of sketches in Carrel Notebook
   a. p. 11 Sleet Formation
   b. p. 12 Hail Formation in Cumulonimbus Cloud
   c. p. 5 Convection
   d. p. 13 Air Mass Source Regions - North America
8. Examination of slide of cold and warm fronts
9. Completion of Exercises 5 and 6, Earth Science Manual
10. Post-test, Unit Four, part two

Materials:
1. Evaporation Kit - ESCP
   a. 1 simple double-beam balance (plastic)
   b. 2 metal holders to support sponges on balance
   c. 2 2 x 1/2 inch cellulose sponges
   d. Water supply
   e. Paper toweling
   f. 150-watt lamp and support
2. Instruction sheet for evaporation investigation
3. Relative humidity equipment
   a. Psychrometer - ESCP
b. Water supply

c. Temperature conversion table - from °C to °F

d. Psychrometric table

4. Instruction sheet for relative humidity investigation

5. Slides

a. Low clouds

b. Middle clouds

c. High clouds and clouds of vertical development

d. Cumulus Clouds

e. Cumulus Clouds

f. Towering cumulus clouds

g. Aerial view of towering cumulus clouds

h. Stratus cloud layer

i. Stratus cloud layer, obscuring much of Eiffel Tower

j. Stratus cloud layer, most of Eiffel Tower observable

k. Stratus cloud layer, bottom very near ground

l. Stratocumulus clouds, layered effect

m. Stratocumulus clouds, arranged in lines

n. Altocumulus clouds, flattened

o. Altocumulus clouds, likened to sheep's backs

p. Altostratus clouds, corona effect behind Eiffel Tower
q. Cirrus clouds, delicate and fibrous appearance
r. Cirrus clouds, long bands
s. Cirrus clouds, mare's tail
t. Cirrus clouds, mare's tail
u. Cirrostratus clouds, halo effect
v. Cirrostratus clouds, halo effect
w. Cirrocumulus clouds, likened to rippling sands at the seashore
x. Cirrocumulus clouds, rippling sands effect
y. Cumulonimbus clouds, with cauliflower appearance
z. Cumulonimbus clouds, with developing anvil-shaped top
aa. Cumulonimbus clouds, with towers
bb. Cumulonimbus clouds, with excellent anvil-shaped top
cc. Cumulonimbus clouds, with excellent anvil-shaped top
dd. Cumulonimbus clouds, with rainstorm
e. Cumulonimbus clouds, with breastlike pouches
ff. Cumulonimbus clouds, with tornado striking the earth

6. Carrel Notebook
   a. p. 11 Sleet Formation
   b. p. 12 Hail Formation in Cumulonimbus cloud
Bal and linear scale, and representative fraction or fractional scale,

3. differentiate between scale and contour interval,

4. determine elevation on the topographic map through the use of contour lines,

5. illustrate a topographic profile or cross-section along a line on a topographic map,

6. determine the area of a portion of a topographic map,

7. identify highest and lowest points, maximum relief, and stream flow on a portion of the map,

8. identify several cultural features such as roads, houses, and barns by using the topographic map symbol sheet on page 130 of the Earth Science Manual.

Activities:

1. Pre-test, Unit Five, part one

2. Locating farm property on Muncie East Quadrangle, Indiana topographic map, using description given on page fourteen of Carrel Notebook

3. Examination of sketch in Carrel Notebook

   p. 15 Range and Township System of Land Survey


5. Completion of Exercise 11, Earth Science Manual

6. Post-test, Unit Five, part one
c. p. 5 Convection
d. p. 13 Air Mass Source Regions - North America

7. Tape Cassette Lecture, Unit Four, part one,
   Meteorology - Water in the Air - Hydrologic Cycle,
   Relative Humidity, and Clouds

8. Tape Cassette Lecture, Unit Four, part two,
   Meteorology - Water in the Air - Precipitation,
   Air Masses, and Fronts

9. Exercises 5 and 6, Earth Science Manual

10. Pre- and post-tests, Unit Four, part one

11. Pre- and post-tests, Unit Four, part two

Unit Five Land Survey Systems and Topographic Maps

Content: This unit includes two audio-taped lectures and laboratory work concerning use of land survey systems and reading of topographic maps. The students will examine the Muncie East Quadrangle, Indiana topographic map for the map exercise.

Objectives: Upon completion of this unit, the student should be able to:

1. determine several locations on a topographic map by using the U.S. Congressional Township Land Survey System, sometimes known as the township and range system or rectangular survey system,

2. describe different types of scale including ver-
7. Pre-test, Unit Five, part two - A
8. Pre-test, Unit Five, part two - B
9. Contour Model Investigation
10. Examination of introductory pages, Exercise 12, Earth Science Manual
11. Completion of Muncie East Quadrangle, Indiana section, Exercise 12, Earth Science Manual
12. Post-test, Unit Five, part two - A
13. Post-test, Unit Five, part two - B

Materials: 1. Carrel Notebook
   a. p. 14 Farm Property - Sale Advertisement
   b. p. 15 Range and Township System of Land Survey
2. Contour Model Kit - ESCP
   a. 5 clear plastic boxes with lids
   b. mylar plastic, size of box lids
   c. contour model
   d. water supply
   e. crayon
3. Instruction sheet for Contour Model Investigation
5. Pre- and post-tests, Unit Five, part one
6. Pre- and post-tests, Unit Five, part two - A
7. Pre- and post-tests, Unit Five, part two - B
8. Tape Cassette Lectures, Unit Five
Unit Six Minerals: The Building Blocks of Rocks

Content: This unit is the first of two units concerning minerals and rocks. The unit includes an audio-tape lecture and laboratory work.

Objectives: Upon completion of this unit, the student should be able to:

1. identify twelve minerals by their physical properties as given by the investigator and the Earth Science Manual, pages ninety-five to ninety-seven. These properties include crystal form, luster, color, streak, diaphaneity, hardness, cleavage, fracture, tenacity, specific gravity, and taste,

2. recognize the chemical property of effervescence in calcite by cold, dilute hydrochloric acid,

3. perform a specific gravity test with one mineral specimen, and

4. relate the minerals to rocks when discussed in Unit Seven.

Activities: 1. Pre-test, Units Six and Seven

2. Examination of twelve mineral specimens

3. Testing of calcite for effervescence in cold, dilute hydrochloric acid

4. Specific gravity investigation, using rock crystal quartz crystal
5. Examination of introductory pages, Exercise 10, Earth Science Manual

Materials: 1. Twelve mineral specimens
   a. Galena
   b. Halite
   c. Calcite
   d. Rock Crystal
   e. Iron Pyrite
   f. Talc
   g. Feldspar
   h. Selenite Gypsum
   i. Mica
   j. Serpentine: var. Chrysotile
   k. Magnetite
   l. Chert

2. Porcelain streak plate
3. Dilute (5 per cent) hydrochloric acid in dropper bottle

4. Specific Gravity Investigation
   a. Chaus Harvard Trip Balance and Weights
   b. Quartz crystal
   c. String to attach quartz crystal to balance
   d. 150 ml beaker
   e. Water supply
   f. Ring stand

5. Instruction sheet for specific gravity investigation


7. Tape Cassette Lecture, Unit Six
8. Pre-test, Units Six and Seven
Unit Seven  The Rock Cycle and Rock Identification

Content: This unit is the second of two units concerning minerals and rocks. The unit includes one audio-taped lecture and laboratory work.

Objectives: Upon completion of this unit, the student should be able to:

1. describe the rock cycle, and
2. identify eighteen rock specimens and their characteristics as given by the investigator and the *Earth Science Manual*, pages ninety-eight and ninety-nine.

Activities: 1. Examination of sketch in Carrel Notebook p. 16 The Rock Cycle

2. Examination of eighteen rock specimens

3. Examination of introductory pages, Exercise 10, *Earth Science Manual*

4. Reexamination of twelve mineral specimens

5. Post-test, Units Six and Seven

Materials: 1. Carrel Notebook p. 16 The Rock Cycle

2. Eighteen rock specimens
   a. Granite  e. Obsidian
   b. Diorite  f. Pumice
   c. Gabbro  g. Scoria
   d. Basalt  h. Conglomerate
i. Sandstone
j. Shale
k. Fossiliferous Limestone
l. Oolitic Limestone
m. Gneiss

n. Marble
o. Slate
p. Phyllite
q. Schist
r. Quartzite


4. Twelve mineral specimens examined in Unit Six

5. Tape Cassette Lecture, Unit Seven

6. Post-test, Units Six and Seven

**Unit Eight Soils**

**Content:** This unit includes one audio-taped lecture and laboratory work concerning soils.

**Objectives:** Upon completion of this unit, the student should be able to:

1. define the term soil,
2. label a sketch of and identify characteristics of a soil profile,
3. describe and demonstrate porosity and permeability,
4. identify great soil groups, given one or more characteristics of each soil group discussed,
5. recognize the location of several great soil groups on a generalized soils map, and
6. define structure and texture in soils.

**Activities:**

1. Pre-test, Unit Eight
2. Examination of sketches in Carrel Notebook
   a. p. 17 The Soil Profile
   b. p. 18 Generalized Soils Map - North America
3. Soil Texture Investigation
4. Examination of three soil micromonoliths
5. Porosity-Permeability Investigation
6. Post-test, Unit Eight

Materials: 1. Carrel Notebook
   a. p. 17 The Soil Profile
   b. p. 18 Generalized Soils Map - North America
2. Soil Texture Investigation
   a. Soil Sieve Set - ESCP
   b. Soil Sample from Prairie Creek Reservoir, Delaware County, Indiana
3. Instruction sheet for soil texture investigation
4. Soil Micromonoliths
   a. Morley - Upland Soil - Delaware County, Indiana
   b. Wawaka - Till Over Terrace Soil - Delaware County, Indiana
   c. Ockley - Outwash Soil - Delaware County, Indiana
5. Porosity-Permeability Investigation Kit - ESCP
   a. 3 plastic tubes - 30 inches long x one inch
   b. Stopper ends for plastic tubes, with clamps
   c. Wire screens for bottom of plastic tubes
d. 100 ml each of 4 mm, 7 mm, and 12 mm beads
e. Water supply
f. 3 ring stands and clamps
g. 3 100 ml graduated cylinders
h. Paper toweling

6. Tape Cassette Lecture, Unit Eight
7. Post-test, Unit Eight

Unit Nine General Geology

Content: This unit includes one audio-taped lecture and laboratory work concerning the area of general geology.

Objective: The objective of this final unit is to whet the students' appetite for further course work in earth science, particularly geology.

Activities: 1. Stream table investigation

2. Examination of twenty-one 13" x 18" geology/landform study prints

3. Examination of seventeen geology slides

Materials: 1. Hubbard Stream Table with plastic liner, sand, recycling motor, and water supply

2. Nystrom 13" x 18" geology/landform study prints
   a. Valley - Hudson River, New York
   b. Coastline - Chesapeake Bay, Maryland
   c. Plateau - Piedmont Plateau, Maryland
   d. Valley - Shenandoah Valley, Virginia
   e. Plain - Great Lakes Lowland, Ontario
f. Plain - Central Lowlands, Illinois

g. Plateau - Ozark Plateau, Missouri

h. Plain - Great Plains, Nebraska

i. Glaciated Valley - Glacier National Park, Montana

j. Glacial Lakes - Kings Canyon National Park, California

k. Oxbow Lake - Afton, New York

l. Valley - Athabasca River, Alberta

m. Valley - Kootenay River, British Columbia

n. Niagara Falls and River - Niagara Falls, New York

o. Entrenched Meander - Goose Neck, San Juan River, Utah

p. Meandering River - Pontiac, Michigan

q. Crater Lake - Crater Lake, Oregon

r. Coastline - Coast Ranges, California

s. Channel - Golden Gate, California

t. Fiord - Douglas Channel, British Columbia

u. Channel - Inside Passage, Alaska

3. Slides

a. Igneous sill with columnar jointing

b. Mount Fujiyama, Japan

c. Folded rock strata

d. Normal fault
e. Smooth, ropy lava (Pahoehoe)
f. Cinder cone volcano
g. Tightly-folded sandstone
h. Devil's Tower, Wyoming
i. Cave in limestone
j. Igneous dike
k. Sandstone arch in Utah
l. Towers and minarets in dryland climate
m. "Mushrooms" in dryland climate
n. Exfoliation
o. Petrified wood
p. Faulting in mountainous area
q. Geyser - Yellowstone National Park, Wyoming

4. Tape Cassette Lecture, Unit Nine
APPENDIX II

EXAMPLES OF TAPE CASSETTE LECTURES

UNIT ONE EARTH MEASUREMENTS

UNIT THREE METEOROLOGY - ENERGY AND AIR MOTION
Unit One
Earth Measurements

Upon completion of this unit, you should be able to:
1. describe the size and shape of the earth,
2. use linear and angular measurements in establishing location on the earth surface, and
3. be able to identify and describe the difference between great and small circles on the globe.

As you will note in completing this lesson, it is very important that you bring appropriate materials with you when using the study carrel. Always bring the Earth Science Manual and the atlas. Upon occasion, you may be asked to bring other materials such as the rock and mineral kit. Other materials will be provided for your use.

O.K., let's get started. One of the essential skills of the physical geographer or earth scientist is his ability to locate places on the earth surface by the use of globes and maps. This skill is also required of students specializing in numerous other fields. Discussion of topographic features, tracing of transportation routes, and comparisons of specialty maps such as population distribution and vegetative types are among types of study requiring a method of describing location. Further, since ancient times, man has wondered about the place of the earth in our solar system. Plato, Aristotle, and Eratosthenes were among early historians who wondered about the size and shape
The shape of the earth is an oblate spheroid. That is, it is nearly round, being somewhat flattened at the poles and bulging out at the equator. This bulging is caused by the outward pull away from the center of the earth during earth rotation, the outward force being called centrifugal force. Thus, the earth is nearly round. How can we be certain that the earth is nearly round? Pictures taken of the earth from satellites as they revolve around the earth and move to and from the moon give us some indication of the true shape. And .... what happens to the silhouette of a ship as it moves away from the observer standing at sea level? Note the sketch on page two of the carrel notebook. The farther seaward the ship moves, the less of the ship that can be seen. Finally, about eighteen miles from shore, the ship disappears. This is due to the curvature of the earth.

Will you now please turn on the slide projector and focus the machine as you have been previously instructed? Note in the first slide a picture taken of a salt flat in western United States. Even here a slight amount of curvature may be discerned. Please turn off the projector at this time. Of course, pictures taken from satellites give us our best present-day evidence that the earth is certainly spherelike. If you will turn around and examine the Apollo 8 and 9 photos on the wall, the sphere shape of the earth is obvious.
about twenty-seven miles less than the equatorial diameter. Let us assume, then, that the earth is an oblate spheroid in shape, that the circumference is about 25,000 miles, and the diameter is 8,000 miles.

Our next problem is how we can locate ourselves on the earth surface. In working with this problem, you will want to turn the slide projector on again and view several slides. You will also use the small globe provided in the study carrel. And, you will then be working with Exercise 1 in the Earth Science Manual. Carefully examine the next four slides (two through five) concerned with latitude and longitude and then the tape player should be turned back on. ....Back with me? What did you notice concerning the slides? I hope you became aware that geographers have devised a grid system for effectively locating places on the earth surface. Using the reverse button on the slide projector control, return the slide tray to slide two. There you will note a group of east-to-west extending lines on the round earth. When I say round, of course, I am referring to the oblate spheroid. These lines are called parallels, or latitude lines, and are used to measure north or south positions from the equator, the parallel dividing the earth into northern and southern hemispheres. You will also note that this part of the grid system can be placed on a rectangular basis as well as on the spherelike earth.

O.K., next slide, please. This view illustrates north-to-
south extending lines called meridians or longitude lines. These lines are used to measure east or west locations from the prime or first meridian which passes through Greenwich, England. This meridian, by the way, is sometimes called the Greenwich Meridian. We can measure 180° east or west from the Prime Meridian to the International Date Line. The International Date Line will be discussed later.

Next slide, please. This slide illustrates a simplified view of latitude and longitude. ...And, the final slide. This slide indicates parallels and meridians on globes or spheres and then illustrates these lines transposed onto a rectangular projection of the world; really, a rather simple type of grid system.

Now, on the small globe in your study carrel, again note the two sets of lines, the parallels and meridians. Locate the equator, the zero (0) line of latitude. Then, locate the prime meridian, the zero (0) line of longitude. Notice how this latter line passes almost through the dot for London, but not quite. Greenwich, previously mentioned, is a suburb of London. The line passes through a scientific observatory located there. The number of parallels and meridians on the globe do not correspond with those you viewed on the slides. What might you infer from this difference? Nothing? Well, no, the inference is that the number of parallels and meridians that may be placed on maps or globes is infinite, that man may utilize the number
plied in your study carrel, place one part of the band at San Francisco. Stretch the band taut across the globe to Tokyo. Compare this distance to the so-called straight-line route of the 38th parallel. The shortest route is to arc a route northwestward from San Francisco and then back southwestward to Tokyo. This line describes what geographers call a great circle or great circle route. Great circles are always the shortest distance between two points on a globe or the earth. Further, all great circles would cut the earth exactly in half if a plane or flat surface were passed through them. How many meridians are one-half of great circles, or simply, great circles? How many parallels are great circles? All meridians, that's all meridians, are one-half of great circles. The equator is the only parallel that is a great circle. All other parallels, such as 28° N for example, are called small circles. Oblique lines that would also cut the earth in half would be called great circles, too. Other oblique lines that would not cut the earth exactly in half are called small circles.

At this time, collect your thoughts and then ask the room supervisor for the post-quiz for this unit. As soon as you complete the post-quiz, you may leave. Be sure to sign out as you leave. And, remember, any time you believe that you need help, come and see me. After all, part of my job is to help you complete this course successfully.
If we then accept the idea that the earth is an oblate spheroid, perhaps we now would be interested in discovering more about the size of the earth, the circumference and the diameter. Please turn to page three in the carrel notebook. Eratosthenes, a Greek geographer who lived between 276 B.C. and 194 B.C. made a surprisingly accurate estimate of the earth circumference. He had read that a deep vertical well at Syene in southern Egypt (this is now the area of the Aswan Dam) was entirely lit up by the noon sun once a year. He reasoned that if this were so the sun must be directly over the well. In Alexandria, almost directly north of Syene, he knew that a vertical object would cast a shadow on that same day and time. Eratosthenes thus reasoned that two assumptions could be made: 1) the earth is round, and 2) the sun rays are essentially parallel. He set up a vertical post at Alexandria and measured the angle of its shadow on the day the sun was directly overhead at Syene. He knew from geometry that the size of the measured angle equaled the size of the angle between Syene and Alexandria (at the center of the earth). He also knew that the arc of this angle was one-fiftieth of a circle, and that the distance between Syene and Alexandria was about 500 miles. Thus, Eratosthenes multiplied 500 by 50 to find the earth circumference. His result, about 25,000 miles, was quite close to modern measurements. Knowing the circumference, we can again, through the use of geometric formulas, determine that the diameter of the earth is about 8,000 miles, with the polar diameter being
which is convenient for him to use in any given situation. I would think that more latitude and longitude lines will be used when we want to locate very specific locations and fewer lines for locating a place in a general way.

If you will now turn in the *Earth Science Manual* to pages 1, 2, and 3, the reading of these pages will further emphasize the principles of latitude and longitude and will better prepare you to work out the exercise which follows on pages five through eight. After you have read the introductory pages, work the problems with the aid of your atlas. When you complete the exercise, hand the exercise to the room supervisor and return to the tape player for further information. Be sure to look at the direction sheet posted in the study carrel for the exact questions to answer in the exercise.

Back with me? The last concept of this lesson is related to working with the geographic terms, great and small circles. Ship navigators have long used the grid system of parallels and meridians to help locate themselves on maps and globes as they move from one place to another on the earth. A map, in itself, or a globe for that matter, does not always indicate the shortest route between any two places. For example, using the globe, find San Francisco, California and Tokyo, Japan. What is the shortest route to take if you want to travel to Tokyo to complete a business deal? Would you think that one should travel westward along the 38th parallel north latitude? Using a rubber band sup-
Unit Three

Meteorology - Energy and Air Motion - Part 1

We are now starting our discussion of meteorology or weather. This topic is probably the one subject that everyone talks about more than any other in our day to day conversations. Upon completion of this unit, you should be able to:

1. provide an explanation of the radiative balance of the earth and the energy budget,

2. describe the heating processes of radiation, convection, and conduction,

3. account for the different rates at which energy is absorbed by land and water,

4. explain how the spherical shape of the earth and its rotation help determine the distribution of incoming radiation,

5. describe Coriolis Effect,

6. explain the relationships between temperature and pressure as they relate to wind patterns, and

7. recognize the use of several weather instruments.

Weather is the state or condition of the atmosphere over a given, usually short, period of time. When we talk about this state or condition, we are thinking about such phenomena as air temperature, pressure, winds, moisture, and precipitation. This unit concerns radiation, convection, and conduction; temperature, pressure, and wind relationships; and, effects of differential
heating and cooling of land and water upon general air circulation. The unit will be divided into two parts.

Let us first take up the concept of heating of the earth through the processes of radiation, conduction, and convection. The sun provides the energy at the earth's surface which is turned into heat. The energy that passes from the sun to the earth is in the form of very short, visible, or light rays. The earth, and its atmosphere to a much smaller degree, absorb the short wave radiation and reemit these waves in the form of long waves, or heat. This process is termed radiation. Radiation by the earth and its atmosphere, then, is felt as heat rather than seen as light. The heat represents a flow of energy; the energy is not lost in powering air and water circulation. All objects do not radiate heat at the same rate of speed. For example, on a given sunny, summer day, you may have walked barefoot on sand, grass, or asphalt. The different materials upon which you walked provided different temperatures which your body felt. In nature, similar differences are noted. We need to remember that the nature of the surface is quite significant in regard to the amount of short waves that will be absorbed by the earth and then reemitted as heat. Dark materials absorb more radiation than light materials. When one thus thinks of differences in the earth's surface such as ripened wheat, green corn, bare soil, etc., different heat radiation will be given off.

In order to illustrate that the nature of the surface does affect the temperature as radiation goes on, I would like for you
to work with a rather simple experiment which, by analogy, should help you to better understand radiation. On the tables here in the room there are several light bulb-thermometer-can setups. There are two cans, one with a black outer surface, the other with a metallic silver surface. Thermometers have been placed in styrofoam in the cans. Don't worry about that because you won't be converting the temperatures to Fahrenheit degrees. Go to any one of the laboratory stations. With the equipment is an instruction sheet. Read the instruction sheet carefully, complete the experiment, and then return to the tape player for more information.

Back with me? I hope you were able to see that the black cup heats more rapidly than the silver cup. If we think of the light bulb as the sun and the cups as different kinds of earth surface, we can realize that there is differential heating of the earth's surface, even in localized situations. There is a radiative balance involved between incoming and outgoing radiation. That is, the radiation of heat waves will be directly proportional to the amount of short wave radiation received from the sun. Cloudy skies will cut down the amount of short wave radiation received at the surface. The differing angles that the sun rays strike a given place on the earth's surface at different seasons or differing times of the year allow for more or fewer short waves to strike the earth. An examination of the sketch on page four of the carrel notebook indicates that there will be differences in insolation (energy received at the earth from the sun) due to
differing areas covered by equal numbers of sun rays at different latitudes. The more direct rays, such as those in summer, concentrate a given bundle of short waves in a smaller area and will thus provide for greater heating. The same bundle of rays striking the earth at an angle of less than 90 degrees, which is to say at higher latitudes, is spread over a horizontal area of the earth considerably larger, thereby providing for lesser heating. Please keep in mind that the greatest heating of the earth (and cooling for that matter) takes place through radiation.

The second heating process in the atmosphere is convection. Think back to your earlier public school days. In earlier science courses, such as general science, you learned that warm air rises and cool air sinks. If you can then imagine a situation where, in a rather localized situation, surfaces of different natures are heated at different rates of speed, the air above the different surfaces will move at different speeds. Examine sketch number five in the carrel notebook which illustrates convection. The hot air rises and cools as it moves away from the heat source. The cool air moves in horizontally to replace the hot air. The rising air, which has been cooling, sinks to replace the cool air at the surface, etc., and the cycle then repeats itself, a cycle that we call convection. I might say that this type of heating causes formation of cumulus clouds, a topic we will be discussing a little bit later.

Of third importance in heating and cooling the atmosphere is
conduction. By definition, conduction is the direct warming or cooling of a material by another material when they are in direct contact. The rapidly moving molecules of warm air hit the low-energy, slowly moving cool air molecules in rapid motion. The high energy is transferred to the cooler material. You have experienced this transfer of heat when you have stirred hot soup with a metal spoon. The heat is transferred from the soup, to the spoon, to your hand. In all cases, this is direct transfer of heat. By analogy, the air of the atmosphere that is in direct contact with the earth is heated by conduction.

A fourth type of heat exchange, adiabatic heating and cooling, will be discussed a little later.

As a change of pace, let us take a little time to talk about some of the weather instruments that are used in the field of meteorology. It is important that the weather observer be as accurate as possible in making weather observations because it is from these observations that weather forecasts are made. Some of the weather equipment is located outside and must be used outside. Other equipment is located outside, but is connected electrically to equipment in the weather station. Still other weather instruments may be housed inside the weather station.

At this time, turn on the slide projector to the first slide. On this slide is a typical weather instrument shelter used to house several weather instruments. The box portion has
blowing from the north to the south. The anemometer is a three-cup unit which rotates at speeds directly proportional to wind velocity. At the bottom of the instrument, out of your sight, is a small generator. The faster the cups turn, the more electricity is generated through the wire to the meter inside the weather station. Next slide, please.

This slide indicates two atmospheric pressure measuring devices, the mercurial barometer that the man is reading, and the aneroid barometer. The aneroid barometer contains a chart which is wrapped around a cylindrical clock unit. A pen arm and point are attached to the active pressure unit, and, as the pressure changes and the clock unit rotates once each week, a continuous trace is drawn on the chart. This makes the aneroid handy for a permanent type of pressure reading that can be checked from time to time. The term aneroid (that's a-n-e-r-o-i-d) comes from the Latin word which literally means without fluid. The active pressure unit consists of partially-evacuated cylinders which press in and out depending upon the atmospheric pressure. The mercurial barometer is a long, thin, glass tube filled most of its forty-inch length with mercury. The upper end of the tube is closed and the bottom end is in a small dish of mercury. Note the sketches on page six of the carrel notebook. Changes in atmospheric pressure cause the mercury to rise and lower in the glass tube. The observer reads pressure in how many inches of mercury there are in the glass tube at the time of the observation.
its base about four feet from the ground. Inside the shelter, we wish to simulate shade conditions as closely as possible. The shelter, therefore, is painted white to reflect as much insolation as possible. You will note that the front and sides of the shelter are louvered so that air is free to pass into and through the shelter. The term louvered is used to describe the boards that are set at an angle in a manner similar to venetian blinds at what you might say have been placed at half-mast. Next slide, please.

This slide consists of two parts: the upper section shows the minimum and maximum thermometers. These are the thermometers from which your TV weather man obtains the information concerning the high and low temperatures for a given day. In the lower segment of the slide, the observer is holding a psychrometer (that's p-s-y-c-h-r-o-m-e-t-e-r), a double thermometer unit from which the observer obtains relative humidity. You will be determining the relative humidity of this room in another unit, using a psychrometer. Next slide, please.

This slide contains two different kinds of weather instruments, two wind vanes and two anemometers (that's a-n-e-m-o-m-e-t-e-r). These instruments are connected electrically to dialed instruments inside the weather station. You may see these dials outside our weather station at the other end of the next corridor of this building, on this floor. The wind vane points into the wind, giving us the direction from which the wind is blowing. That is, if the arrow points north, the wind is
Another unit of measurement of pressure used by meteorologists is the millibar (that's m-i-l-l-i-b-a-r), a very accurate unit for measuring pressure. At mean sea level, the average pressure of a column of air one inch square and extending down through the atmosphere to sea level is about 14.7 lbs./sq. inch. Converting this average pressure to a reading from the mercurial or aneroid barometers gives us 29.92 inches of mercury in the glass tube. This number equals 1013.2 millibars of mercury.

Keep in mind that atmospheric pressure falls as one rises above sea level and increases as one goes below sea level, such as into Death Valley. In addition, a good rule to follow is: regions of high temperature have lower atmospheric pressure because the air is rising, and regions of low temperature have higher atmospheric pressures because the air is sinking.

This is the end of part one of unit three. You will not take the post-test for this unit until the end of part two of this unit.

Unit Three

Meteorology - Energy and Air Motion - Part 2

In the first lesson of this unit, we took up the concept of heating of the earth and its atmosphere through the processes of radiation, convection, and conduction; we examined several weather instruments; and we ended the lesson with a discussion of atmospheric pressure. In this lesson, today, you will be working with differential heating (and cooling) of land and water
bodies, winds, and pressure cells.

Let me say here at the start that we can hardly discuss air temperature, air pressure, or winds by themselves. The three interact very closely, as is mentioned again and again in the average meteorology course.

So, what about differential heating of land and water? In the first place, water is generally different in color than the land surface. More energy is absorbed by the land and returned to the atmosphere as heat during the day than is the case with water. Secondly, only the near surface area of land is heated because the solid earth molecules do not move very far. There is thus only friction among the molecules near the surface with resulting heating being concentrated near the surface. In fact, insolation effects affect only about the first fifty feet below the surface of the land. In the case of water, the water molecules are constantly being moved about by wave and current action. Molecules that may be heated at or near the water surface may then be carried many feet beneath the surface by currents; the surface, then, is more slowly heated. Keep in mind that the lower atmosphere tends to take on temperature and moisture characteristics of the surface beneath. Thus, we can safely say that the land heats more rapidly than the water. At night, the land cools more rapidly than the water because the water has distributed its heat to much greater depths and over much greater areas. Don't forget, then, that land both heats and cools more rapidly than
does water. When we have land and water directly adjacent to each other, what will be the conditions of the lower atmosphere over the land? And, over the water? Think about when you dive into water in the daytime and at night. In the daytime, doesn't the cool water feel good? And, at night, doesn't that warm water feel good?

The land-water, heating-cooling differential holds true on large, areal bases as well as in local situations. Place the globe in the carrel in front of you on the desk. Imagine yourself being the sun. Rotate the earth from west to east. Will different kinds of surfaces be facing the sun at different times of the day and night periods? Of course. In the first place, the big difference between the nature of the surface of continents and oceans can be discerned. Secondly, the earth will give up heat at night just as it does in the daytime. At night, though, the sun isn't there to replenish the heat given off. Thus, the earth and the atmosphere above it becomes cooler. Of course, at night the convection stops as heating stops. Conduction will continue until the atmosphere touching the earth is the same temperature as the earth surface.

We come now to the topic of winds. Keep in mind that radiation, conduction, and convection heat up the surface. Keep in mind that the nature of the surface will determine how much the land is heated, and that there will be differences in the heating because of the nature of the surface. There will be
differences in the amount of insolation due to differences in latitude and angle of the sun's rays striking the earth. Differences will be brought about by the rotating earth, and by differences in land and water. In a sense, this is somewhat of a vicious cycle, but these factors bring about our air circulation. Why? Heating has considerable to do with differences in air pressure. If you will recall, I mentioned the rule about areas of warm air having lower pressures because the air is rising up through the lower atmosphere that is pushing down on us, and cold air, having higher pressures because not only is the usual pressure of the air pushing down on us, but the cold, sinking air adds its weight to the air pressure. Changes in air pressure, in turn, bring about wind. Wind is the horizontal movement of air from areas of high pressure to areas of lower pressure. Let me repeat that. Wind is the movement of air from areas of high pressure to areas of lower pressure. Wind direction is always measured as the direction from which the wind is blowing, not the direction toward which the wind is blowing. For example, a north wind blows from the north to the south. I want to impress upon you that regardless of the wind velocity—whether there is just a little draft of air moving by your face or a gale of 30 miles per hour or a hurricane of 75 miles per hour—by definition, these movements of air are movements of air from areas of high pressure to areas of lower pressure. When the pressure change is very great in a short distance, we will
experience higher wind velocities. When the pressure change is
not very great in a short distance, or in a long distance for that
matter, the wind velocity will be much lower.

On the table behind the study carrels, is a portable wind
measuring device. An instruction sheet is provided for your use.
At this time, examine the wind measuring device—the wind vane
and anemometer—following the directions on the instruction sheet.
Complete the investigation, and return to the tape player for
further information.

Back with me? Good! What wind direction did you obtain?
What wind velocity? The portable instrument you worked with is
commonly used by meteorologists in locations where it is not
practical to set up permanent equipment, when money is not
available to build permanent facilities, and for use when perman­
ent equipment is inoperative. If you are a track enthusiast, you
may have seen wind measuring devices being used at trackside to
determine wind velocities. When wind velocities are rather high,
track records made on that particular day may not be recorded as
new records.

When meteorologists discuss winds, there are several groups
of winds that they are interested in. One of these includes
the world wind belts. In the carrel notebook, page seven, you
will see an illustration of world wind belts. The larger sketch
indicates winds as we might observe them standing out in space at
eye level with the equator. The smaller sketch at the bottom of
the page illustrates a side view. I would state that the explan-
ation I am going to give you concerning air circulation on a world-wide basis may be partially erroneous because we still just don't know that much about upper-air circulation. For our purposes, however, the explanation will be satisfactory. In keeping with our need to continually relate air temperature, air pressure, and winds, note in the lower drawing that surface winds are moving toward the equator in both hemispheres. Greatest insolation occurs over the equatorial regions. Thus, greater heating occurs there, with resulting rising air and lower air pressures. Air, then, moves horizontally toward the equator at the surface. As this air is warmed and rises, it begins moving toward the poles. Some of the air moving toward the poles is sufficiently cooled at about 30 degrees north and south latitudes that it sinks to the surface, the remainder of the air aloft moving toward the poles. The air that reaches the surface at the latitudes of the thirties divides, with some of the air moving toward the poles and some of it moving back to the equator, in both cases at or near the surface. The air that reaches the poles is quite cold, sinks, and moves equatorward to meet the air coming from the thirties, and so on.

Now, if we had a non-rotating globe our explanation of world wind and air circulation would be completed. Our problem is that we do have a rotating globe, in which case we must bring a new term into our thinking here, namely Coriolis force or Corio-
Coriolis effect (that's C-o-r-i-o-l-i-s). You will see that the word effect is more appropriate than force because no force is really involved. Assume yourself to be standing at the north pole, and that you are going to throw a ball to someone standing at the equator. You throw the ball. It takes several hours for the ball to get to the equator. After all, it is about 6,000 miles. The person standing at the equator will miss the ball. Why? By the time the ball gets to the equator, the man at the equator will have moved on eastward (remember: the earth, at the equator, is rotating at a rate of about 1,000 miles per hour). From your frame of reference at the north pole, then, it will appear to you that you have thrown the ball to your right. In the southern hemisphere, it would have been to your left. A rule can thus be made: Coriolis effect is an apparent force which in the northern hemisphere deflects moving objects to the right and in the southern hemisphere deflects moving objects to the left. Thus, if we look at the global picture (large sketch, page seven in the carrel notebook), we see that, instead of straight north-south wind movements, winds in the northern hemisphere are indeed deflected to the right, and those in the southern hemisphere are deflected to the left. Keep in mind that this right-left deflection is from the frame of reference of the beginning or origin point of the wind movement. As is shown in the sketch, names are given to the several wind belts: the northeast and southeast trade winds, the prevailing westerly winds, and the polar east-
erly winds, the wind direction given as the general direction from which the wind is blowing. Because of the rising air of the equatorial region and the latitudes of the sixties, and the sinking air of the thirties and the poles, we have alternating belts of low and high pressure which are named in the sketch. The latitudinal location of these pressure belts (and the wind belts) changes with the seasons. Why? Would not the wind and pressure belts follow the latitudinal position of the noon sun?

In addition to world wind belts, there are several local winds of much significance, namely: sea breezes and land breezes, valley and mountain breezes, and the chinook, or foehn wind. Land and sea breezes (see page eight, carrel notebook) have to do with land-water relationships in rather localized situations. These breezes are felt to a maximum of about twenty to thirty miles inland from shorelines of such places as the Normandy coast of France, the Mediterranean seashore, along the shores of the Great Lakes such as Lake Michigan. If we remember that the land heats faster than water in the daytime, what type of pressure will be experienced over the land at that time with respect to the water? Over the land we will have lower pressure, over the water higher pressure. If we have these air pressure differences, then, will we have wind? Certainly! During the daytime the air will be blowing from the sea toward the land. Using the rule concerning wind direction, during the daytime there will be sea breezes. At night, when the land gives up its heat more rapidly
than the water, we'll experience higher pressure over the land and lower pressure over the water. The air will reverse its direction of movement and flow back out to sea from the land, the wind being called a land breeze. There is almost a continuous flow of air from sea to land and from land to sea over the twenty-four hour period.

In the case of valley and mountain breezes, in the daytime when the land is heated, the air will rise from the valley up mountain or hill slopes. At night, when the sun is "turned off," the air is cooled and sinks back down the slope from the mountain or hill into the valley. Again, using the rule concerning wind direction, in the daytime valley breezes occur; in the nighttime, mountain breezes occur (see page nine, carrel notebook).

The Chinook or Foehn wind is a rather rare, special wind that is found in our country along the eastern slopes of the Rocky Mountains. When air is forced to rise over mountain areas or other higher ground, this air is cooled at a much faster rate than the surrounding air. This is because a given parcel of air gets up into thinner air, pressurewise, and the molecules are able to move apart more rapidly where there is lesser pressure, thus cooling takes place more rapidly. In addition, condensation takes place on the windward side of the mountain as cooling takes place, and precipitation often takes place (this topic will be taken up in greater detail in the next unit). When the air gets to the leeward or far side of the mountain, it is still much
cooler than the surrounding air and is often much dryer, as well.

Being colder than the surrounding air, our parcel of air sinks
down the leeward slope very rapidly, warms very rapidly, and
the dry air picks up moisture as descent occurs. This warming and
drying wind is called the Chinook or Foehn wind. During a Chi­
nook, the air temperature at the surface may rise from $-15^\circ F$ to
$+30^\circ F$ or $+40^\circ F$ in just several hours.

Finally, and I imagine you are saying finally, we come to
the topic of winds and pressure cells. Your TV weather news­
caster talks about high pressure cells in certain parts of the
country and low pressure cells in others. He then discusses
frontal systems involved with the pressure cells (these will be
discussed in the next unit). What the newscaster is discussing
(see page ten, carrel notebook) is as follows: when he discusses
a high pressure cell, he is talking of cold sinking air in a
particular area of the country, sinking air which moves away from
the center of the high pressure in a clockwise direction, in the
northern hemisphere. The high pressure cell is called an anti­
cyclone. When you see a pile of leaves or a cloud of dust moving
in a clockwise direction, you are observing a miniature high pres­
sure cell. On the other hand, if the leaves or dust are moving
toward the center of a small cell and the direction of movement is
counter-clockwise, in the northern hemisphere, a cyclone is
occurring. A cyclone is a low pressure cell, the winds blowing
counter-clockwise and toward the center of the low. You can note,
in the side views, that in the anticyclone, sinking air is involved; in the cyclone, rising air is involved. As these pressure cells move across the United States, air may move from an anticyclone into a cyclone; the air may rise in the cyclone and sink down into an adjacent anticyclone, etc.

At this time, take the post-test for this unit. In the next unit, we will be discussing meteorology - water in the air.
APPENDIX III

EXAMPLES OF CARREL NOTEBOOK SKETCHES

EARTH SHAPE - OBLATE SPHEROID

AN EFFECT OF EARTH CURVATURE

ERATOSTHENES' MEASUREMENT OF EARTH CIRCUMFERENCE
EARTH SHAPE

OBLATE SPHEROID

(Exaggerated View)

North Pole

About 27 miles greater through equator

South Pole

Diameter = About 8,000 miles
Circumference = About 25,000 miles
EFFECT OF EARTH CURVATURE

SHIP VANISHES OVER HORIZON

18 miles - ship disappears from sight

10 miles - ship still seen

line of sight of observer (horizon line)
ERATOSTHENES' MEASUREMENT OF EARTH CIRCUMERENCE

Post

shadow

500 miles

Alexandria

well at Syene 23 1/2° N

1/50 of a circle
APPENDIX IV

LABORATORY INVESTIGATION INSTRUCTION SHEETS
**Unit 3 - Radiation - Insolation Investigation Energy and Air Motion**

**Equipment:**
- Reflector Lamp Unit with 150-watt bulb and stand
- Black cup and silver cup
- Styrofoam caps for cups
- 1 ESGP thermometer for each cup
- Ruler

<table>
<thead>
<tr>
<th>Direction</th>
<th>Black Cup</th>
<th>Silver Cup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature at beginning before light is on; cups 6 inches from base of lamp support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn lamp on; temperature after one (1) minute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature after two (2) minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature after three (3) minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Move cups one (1) foot away from base of lamp support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature after one (1) minute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature after two (2) minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature after three (3) minutes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Move cup with lower temperature closer to light until temperatures are equal.

How close is that cup to the base of the lamp support when temperatures are equalized? ________________

Which cup did you move closer to the lamp? ________________

Your Name: ____________________________

Hand this paper to room supervisor and return to the study carrel.
Unit 3 - Part 2 - Wind Direction and Velocity Measurement - Energy and Air Motion

Equipment: Wind Measuring Set #6052 and labelled sketch
Belfort Instrument Company
Baltimore, Maryland

Electric Fan

1. Carefully examine the wind measuring device, noting the several parts labelled in the sketch.

2. Turn on the electric fan to high speed.

3. Stand on the spot designated on the floor.

4. Grasp the instrument by the handle, with the right hand, and hold it in an approximately vertical position at arm's length with sight at eye level.

5. Aim the instrument at the North orientation point just to the right of the pencil sharpener by aligning the center of the slot in the front sight with the center of the opening of the sight nearest the eye.

6. Now, bring the instrument to about chest level.

7. Depress and hold the vane-locking trigger (at the front of the handle). The wind vane will swing around into the wind being generated by the fan.

8. Record the wind direction, using the compass directions shown on the floor.

| Wind Direction |

9. With instrument again at chest level, note the wind velocity on the dial. If the velocity is below 15 knots, as indicated on the 0-60 dial, depress the range switch toward you, and read and record the wind velocity.

| knots |

10. Carefully replace the instrument on the table, turn off the fan, place your name on this paper, hand it to the room supervisor, and return to the tape player for more information.

Your Name: ________________________________
Unit 4 - Part 1 - Evaporation Investigation - Water in the Air

Equipment: Single Beam Balance on a center point - ESCP
Two sponges
Water-alcohol mixture
150-watt lamp on reflector support
Paper toweling
Two cereal bowls

1. Dip the two sponges into the water-alcohol mixture and wring out just enough moisture so that the sponges will not drip.

2. Place the sponges on the scales and adjust the balance slide to equalize the balance beam. You may need to squeeze a bit of moisture from one sponge or add some to the other to help in equalizing the weight. The pointer at the center of the balance beam should point to the line in the middle of the beam support.

3. Move the balance apparatus so that the left sponge is about one (1) inch from the lamp. Turn on the lamp.

4. After 3 or 4 minutes, the balance should begin to tilt in one direction. You may need to gently tap the beam at this time to obtain movement.

5. Which side of the balance drops and how long does it take for the pointer at the center of the balance beam to move from the center to the edge of the support?

6. Why does one side of the balance drop?

7. What has happened to the moisture that has left the sponge? How do you know?

8. Has any moisture left the other sponge? How do you know?

9. Why did the instructor provide a water-alcohol mixture instead of just water?

Place your name on this sheet, hand it to the room supervisor, and return to the tape player for further information.

Your Name
Unit 1 - Part 1 - Relative Humidity Determination -
Water in the Air

Equipment: Psychrometer - ESCP
Bowl of water
Centigrade (Celsius) conversion table (on wall)
Psychrometric table
Paper toweling

1. Dip the muslin cloth into the pan of water (bottom of psychrometer) and then spin it with the attached handle.

2. After intervals of 30 seconds, one (1) minute, and 1 1/2 minutes, take a reading of the wet bulb (muslin) thermometer. Continue the procedure at thirty second intervals until the temperature of that thermometer no longer drops.

<table>
<thead>
<tr>
<th>Time</th>
<th>Temp. of wet bulb</th>
<th>Time</th>
<th>Temp. of wet bulb</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 seconds</td>
<td></td>
<td>2 minutes</td>
<td></td>
</tr>
<tr>
<td>1 minute</td>
<td></td>
<td>2 1/2 min.</td>
<td></td>
</tr>
<tr>
<td>1 1/2 minutes</td>
<td></td>
<td>3 minutes</td>
<td></td>
</tr>
</tbody>
</table>

3. At this time read and record the temperature of both thermometers. The thermometer with no muslin cloth is called the dry-bulb thermometer, the other the wet-bulb thermometer.

Dry-bulb temp. ____ °C Wet-Bulb temp. ____ °C

4. Convert the temperatures from centigrade (Celsius) to Fahrenheit using the conversion chart on the wall.

Dry-Bulb temp. ______ ° F

Wet-Bulb temp. ______ ° F

Subtract the wet-bulb temp. from the dry-bulb temp. This answer is called the wet-bulb depression

5. Examine the psychrometric table provided by the room supervisor and determine the relative humidity.

Place your name on this sheet, hand it to the room supervisor, and return to the tape player for further information.

Your Name __________________________
Unit 5 - Part 2 - Contour Model Investigation

Land Survey Systems and Topographic Maps

Equipment: 5 ESCP plastic boxes and lids
5 ESCP Contour Models
1 piece mylar plastic - 6" x 12"
1 dark crayon
Water in each plastic box: box 1 = 1/2 inch deep
box 2 = 1 inch deep
box 3 = 1 1/2 inches deep
box 4 = 2 inches deep
box 5 = 2 1/2 inches deep

You will note that each of the five boxes contains water, each at a different depth. Use one (1) piece of mylar plastic.
- Place the mylar on top of the box lid of one plastic box.
- Using a crayon, trace a line which corresponds to the shoreline or beach.
- Trace the shoreline of each of the other contour models.

When you have traced all five shorelines, you should now have five enclosed contour lines, and will have drawn a simple topographic map.

You will note on the side of each plastic box the elevation of the shoreline is labeled. If you place these elevations on the appropriate contour lines, you can quickly determine the elevation anywhere on the island you have drawn.

What is the elevation of the island? ____________________________

Should a contour line be placed inside the volcano (top of the island)? __________________________

Why or why not? __________________________

You may have difficulty in answering these questions, but the answers should become clear as the exercise continues.

At this time, place your name on this sheet, hand it to the room supervisor, and return to the tape player for more information.

Your Name ____________________________
Unit 6 - Specific Gravity Determination

Minerals, The Building Blocks of Rocks

Equipment: Specimen to be tested
Ring Stand
Single beam trip balance
250 ml. beaker filled to 200 ml. with water
String and paper clip to suspend specimen

1. Place balance on ring stand. This may have been done.

2. Weigh specimen, string, and paper clip. This will provide the weight of the specimen in air.

weight __________________________

Why are you told to weigh the string and paper clip as well as the specimen?

3. Suspend the specimen in the beaker of water by placing the paper clip (which is attached to one end of the string) through the small brass ring under the left side of the balance, on the underside of the balance. Then weigh the specimen again.

weight __________________________

4. Subtract the weight in water from the weight in air.

weight __________________________

5. Divide the answer from step 4 into the weight of the specimen in air. This will give you the specific gravity of the specimen.

Specific Gravity ____________________

At this time, place your name on this sheet, hand it to the room supervisor, and return to the tape player for further information.

Your Name __________________________
Unit 8 - Micromonoliths - Texture and Structure - Soils

Equipment: Soil Micromonoliths
- Morley - Upland Soil - Delaware County, Indiana
- Wawaka - Till Over Terrace Soil - Delaware County, Indiana
- Ockley - Outwash Soil - Delaware County, Indiana

Examine the several parts of each micromonolith and answer the following questions.

1. Which soil appears to contain the most clay? 

2. Which soil appears to contain the most gravel and sand?

3. Which soil appears to be the most uniform in texture?

4. Which soil would probably be the best-drained?

5. If soil structure refers to the arrangement of soil particles, which soil appears to have the most variety in structure of the A soil horizon?

6. Which soil is most likely to become "waterlogged?"

At this time, place your name on this sheet, hand it to the room supervisor, and return to the tape player for more information.

Your Name ____________________________
Unit 8 - Porosity and Permeability - Soils

Equipment: 3 ESCP plastic tubes with screens, hoses, clamps
3 Ring stands and support clamps
3 100 ml graduated cylinders
1 1000 ml graduated cylinder
3 150 ml graduated beakers
Paper toweling
100 ml 7 mm plastic beads - ESCP
100 ml 4 mm plastic beads - ESCP
100 ml 12 mm plastic beads - ESCP
Water supply

POROSITY

1. The apparatus is set up with each size of beads in a different plastic tube.

2. Fill each 100 ml graduated cylinder with 100 ml of water. Be as accurate as you can.

3. Pour water from each graduated cylinder over the beads of each size until the beads are just covered (to the top of the beads). Record the amounts poured.

4. The amounts recorded will be the volume (amount) of pore space between the beads. To measure the porosity, use this formula:

\[
\text{Porosity} = \frac{\text{Pore Space}}{\text{Total Volume}} \times 100\%
\]

4 mm ________%
7 mm ________%
12 mm ________%

By analogy, how does soil texture relate to porosity? ______

5. Now, let the water flow into the beakers from each plastic tube until it begins to drip. Seal the tube with the clamp. Record the amount of water that flowed from each tube.

4 mm ________ ml
7 mm ________ ml
12 mm ________ ml
Unit 8 - Screen Sieve Activity - Soil Texture - Soils

Equipment: Soil Sieve Set - ESCP
Soil sample from Prairie Creek Reservoir, Delaware County, Indiana

1. Put the several parts of the screen sieve set together with the finest screen on the bottom section, the next larger screen immediately above it, etc.

2. Pour the soil sample into the top sieve and cover it with the lid.

3. Shake the sieve vigorously for about one-half minute.

4. Carefully examine the contents of each screen sieve following the "shake" period. Rub a few grains between your thumb and forefinger. Briefly examine the various materials and describe the contents of each sieve.

5. A "good" soil contains many different sized soil particles. Is the sample you are working with a good soil in that respect?

6. Pour the contents of each sieve into the bottom section and leave the laboratory setup as you found it.

At this time, place your name on this sheet, hand it to the room supervisor, and return to the tape player for more information.

Your Name ____________________________
By analogy, how does soil texture relate to water retention?


PERMEABILITY

6. Now, add 300 ml of water to each plastic tube. You will need to lift the plastic tubes upward in the support clamps so that the 1000 ml plastic graduated cylinder will fit under the hoses.

7. Open the hose and record the time it takes for each tube to lose all its water.

<table>
<thead>
<tr>
<th>4 mm</th>
<th>7 mm</th>
<th>12 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>secs</td>
<td>secs</td>
<td>secs</td>
</tr>
</tbody>
</table>

By analogy, how does soil texture relate to permeability?


At this time, place your name on this sheet, hand it to the room supervisor, and return to the tape player for more information.

Your Name ___________________________
APPENDIX V

UNIT TESTS

COMPREHENSIVE TEST

215
Unit Test Questions

Following each question are three groups of numbers. The first group represents item difficulty on the post-test, the second group represents item discrimination on the post-test, and the third group represents the level of thinking required for each question. Each correct answer is underlined.

1. The shape of the earth is:
   a. round
   b. an aberrated sphere
   c. an oblate spheroid
   d. spherical
   e. a and d
   89, 0.27, 1

2. As a ship moves seaward from an observer at sea level, the ship will disappear from view ______ from shore.
   a. 1/2 mile
   b. 5 miles
   c. 10 miles
   d. 114 miles
   e. 18 miles
   92, 0.08, 1

3. Eratosthenes determined that the circumference of the earth was about 25,000 miles. He used a sketch similar to the one which follows. If the distance between Alexandria and Syene had been 800 miles, and the latitude between the two cities had comprised 1/40 of a circle, his determination of earth circumference would have been:
   a. 32,000 miles
   b. 200 miles
   c. 5,000 miles
   d. 320 miles
   e. 500 miles
   94, 0.23, 4

4. All meridians:
   a. extend north to south
   b. meet at the poles
   c. extend east to west
   d. parallel one another
   e. a and b
   54, 0.38, 1
5. Greenwich, England is important in mapping because:
   a. it coincides with the prime meridian and is located at 0° longitude
   b. Columbus sailed from there on his trip to the New World
   c. it is located at the 0° point of latitude
   d. a and b
   e. b and c

6. Use your atlas in answering this question. Detroit, Michigan is located at:
   a. 42° 22' N, 87° 37' W
   b. 42° 22' S, 83° 10' W
   c. 42° 22' N, 83° 10' E
   d. 42° 22' S, 83° 10' W
   e. none of the above

7. The following are great circles (or 1/2 of great circles):
   a. all meridians
   b. all lines which cut the earth exactly in half if a plane is passed through them
   c. the equator
   d. all of the above
   e. none of the above

8. Point A in the sketch is located at:
   a. 35° S, 155° E
   b. 35° N, 155° E
   c. 35° N, 155° W
   d. 35° S, 155° W
   e. 155° N, 35° E

9. Point B in the sketch is located at:
   a. 2° 30' N, 175° W
   b. 2° 30' N, 175° E
   c. 5° N, 175° W
   d. 2° 30' S, 175° W
   e. 5° S, 175° E

10. Point C in the sketch is located at:
    a. 10° N, 150° E
    b. 10° N, 150° W
    c. 10° S, 150° W
    d. 150° S, 10° E
    e. 10° S, 150° E
11. The period of earth rotation is:
a. 24 hours
b. 365 1/4 days
c. 30 days
d. 24 days
e. none of the above 95, 0.04, 1

12. The direction of earth revolution is:
a. east to west
b. north to south
c. south to north
d. west to east
e. varies with the season 80, 0.23, 1

13. The orderly succession of the seasons is the result of:
a. revolution of the earth around the sun
b. the inclination of the earth's axis
c. the constant parallelism of the axis throughout revolution
d. all of the above
e. none of the above 82, 0.23, 3

14. The accompanying sketch illustrates the first day of a season. What season will follow after the season illustrated in the sketch, in the northern hemisphere?
a. Spring
b. Summer
c. Autumn  Sketch
d. Winter 63, 0.46, 5

15. Using the sketch of the above question, which pole will be nearer the sun the first day of the season following the season illustrated in the sketch?
a. the north pole will be nearer the sun
b. the south pole will be nearer the sun
c. neither pole: both poles will be equidistant from the sun 84, 0.27, 4

16. A person located at 40° N, on June 21st, will look _____ to see the sun rise.
a. northeast
b. due east
c. southeast
d. directly overhead
e. due south 27, 0.08, 3
17. It is March 21st. You are located at 25° N. What is the altitude of the noon sun?
   a. 25°
   b. 90°
   c. 31 1/2°
   d. 65°
   e. 45 1/2°

18. If an observer sees the noon sun 60° above his southern horizon on December 21st, what is his latitude?
   a. 60° N
   b. 30° N
   c. 6 1/2° N
   d. 6 1/2° S
   e. 30° S

19. If it is 4:00 A.M., Thursday, at 122° W, what is the time and day at 122° E?
   a. 8 P.M. Wednesday
   b. 8 P.M. Thursday
   c. 8 A.M. Wednesday
   d. 8 A.M. Thursday
   e. none of the above

20. If a shipboard chronometer reads 10:20 P.M. when the navigator observes the noon sun, what is the longitude of the ship?
   a. 155° E
   b. 25° E
   c. 25° W
   d. 155° W
   e. 87 1/2° E

21. The most significant process by which the earth is heated is:
   a. radiation
   b. conduction
   c. convection
   d. all are equally significant

22. Sea breezes blow during the daytime because:
   a. the land heats more rapidly than the adjacent water
   b. the water heats more rapidly than the adjacent land
   c. higher atmospheric pressures exist over the water than over the adjacent land
   d. a and c
   e. b and c
23. The accompanying sketch illustrates:
   a. radiation
   b. conduction
   c. convection
   d. none of the above
   90, 0.04, 2

24. Which of the following influence radiative balance?
   a. the nature of the surface
   b. the angle at which the sun's rays strike the surface
   c. concentration of sun's rays at different latitudes
   d. all of the above
   85, 0.15, 2

25. The weather instrument used to measure wind velocity is the:
   a. wind vane
   b. aneroid
   c. psyshrometer
   d. anemometer
   e. none of the above
   82, 0.15, 1

26. Assume the atmospheric pressure at sea level to be 29.92" of mercury. If you are at 1,000 feet above sea level, the atmospheric pressure will be:
   a. higher than at sea level
   b. lower than at sea level
   c. the same as at sea level
   74, 0.31, 3

27. What mistake (s), if any, do you see in the following sketch of world wind belts?
   a. the northern hemisphere winds are deflected in the wrong direction
   b. the southern hemisphere winds are deflected in the wrong direction
   c. the pressure belts are reversed
   d. the winds between 0° and 30° N and S should be blowing away from the equator
   e. the sketch is correct
   48, 0.35, 3

28. Coriolis effect is an apparent force which in the northern hemisphere deflects moving objects to the left.
   a. true
   b. false
   81, 0.19, 1
35. What is the cloud type in slide 14?
   a. stratus
   b. altocumulus
   c. cumulus
   d. cirrus
   e. cirrostratus
   87, 0.27, 2

36. What is the cloud type in slide 17?
   a. stratus
   b. cirrus
   c. nimbostratus
   d. cumulonimbus
   e. none of the above
   68, 0.35, 2

37. What is the cloud type in slide 24?
   a. stratus
   b. cumulus
   c. cirrus
   d. altostratus
   e. cirrocumulus
   81, 0.38, 2

38. What is the cloud type in slide 29?
   a. cumulus
   b. altocumulus
   c. cirrocumulus
   d. cumulonimbus
   e. none of the above
   76, 0.35, 2

39. In what cloud family does altostratus belong?
   a. low clouds
   b. high clouds
   c. middle clouds
   d. clouds of vertical development
   e. in any of the above families
   93, 0.12, 2

40. In what cloud family does stratocumulus belong?
   a. low clouds
   b. high clouds
   c. middle clouds
   d. clouds of vertical development
   e. in any of the above families
   80, 0.23, 2
29. Anticyclones are activated by:
   a. rising air
   b. sinking air
   c. cold air
   d. a and c
   e. b and c
   \[44, 0.46, 2\]

30. The accompanying sketch illustrates a surface area with a temperature of 60°F, A, and two adjacent areas, each 75°F, B and C. Which of the following should hold true?
   a. A will be a high pressure area
   b. B and C will be high pressure areas
   c. wind will blow from B and C toward A
   d. b and c
   e. none of the above
   \[65, 0.31, 3\]

31. Which of the following are not included in the hydrologic cycle?
   a. condensation
   b. evaporation
   c. precipitation
   d. sublimation
   e. all are included in the hydrologic cycle
   \[81, 0.12, 1\]

32. The direct transfer of a substance from a solid to a gas without passing through the intermediate liquid stage is called:
   a. evapotranspiration
   b. evaporation
   c. sublimation
   d. condensation
   \[90, 0.19, 1\]

33. The amount of moisture in the air at a given temperature compared with the amount of moisture the air could hold at that temperature is termed:
   a. humidity
   b. condensation
   c. evapotranspiration
   d. relative humidity
   \[97, 0.12, 1\]

34. Turn on the slide projector. What is the cloud type in slide 10?
   a. nimbostratus
   b. cumulus
   c. stratus
   \[87, 0.15, 2\]
41. The accompanying sketch suggests that:
   a. hail may occur at the ground
   b. sleet may occur at the ground
   c. rain may occur at the ground
   d. a and c
   e. b and c

42. Which of the following is not a form of precipitation?
   a. rain
   b. dew
   c. snow
   d. hail
   e. all are forms of precipitation

43. In air mass development, if the surface is warm and moist, the lower atmosphere above the surface will be:
   a. warm and dry
   b. cold and dry
   c. warm and moist
   d. cold and moist

44. Identify the type of precipitation in the accompanying sketch:
   a. orographic precipitation
   b. cyclonic precipitation
   c. convectional precipitation
   d. frontal precipitation

45. The sketch illustrates:
   a. a cold front
   b. a warm front
   c. a warm front occlusion
   d. a stationary front

46. In the sketch of question 45, the air at A:
   a. will be colder than the air at B
   b. will be warmer than the air at B
   c. will be the same temperature as that at B

47. Which of the following statements are not true? (above sketch)
   a. rainfall will be violent and of short duration
   b. the front will move at about 15 - 20 miles per hour
   c. cumulonimbus clouds will be common at C
   d. all the statements are true
48. The accompanying sketch illustrates:
   a. a high pressure cell
   b. a low pressure cell
   c. an anticyclone
   d. a and c
   e. b and c

66, 0.35, 2

49. In a warm front occlusion:
   a. the warm front overtakes the cold front
   b. the cold front overtakes the warm front
   c. the front is always stationary
   d. the warm front will leave the surface
   e. none of the above

33, 0.27, 1

50. The following symbol on a weather map indicates:
   a. a cold front
   b. a warm front
   c. an occluded front
   d. a stationary front
   e. frontogenesis

67, 0.19, 2

51. The Metes and Bounds survey system:
   a. is based upon a rectangular survey system
   b. is based upon local landmarks
   c. utilizes 640 acre parcels of land
   d. is commonly used in Indiana
   e. all of the above are correct

85, 0.27, 1

52. The symbol Sec. 16 refers to:
   a. 640 acres
   b. 320 acres
   c. 160 acres
   d. 80 acres
   e. 40 acres

87, 0.15, 1

53. U.S. Congressional Townships:
   a. always coincide with civil townships
   b. need not coincide with civil townships
   c. always coincide with state boundaries
   d. a and c
   e. none of the above

78, 0.19, 2
54. The section number in the following sketch is:
   a. 26
   b. 24
   c. 30
   d. 36
   e. none of the above
74, 0.35, 2

55. In the following sketch, X is located at:
   a. NE 1/4, SE 1/4, NW 1/4, Sec. 16
   b. SE 1/4, NE 1/4, NW 1/4, Sec. 16
   c. NW 1/4, SE 1/4, SE 1/4, Sec. 16
   d. none of the above
75, 0.42, 3

56. In the previous sketch, X contains:
   a. 160 acres
   b. 80 acres
   c. 20 acres
   d. 10 acres
73, 0.35, 3

57. A clue to an aerial observer that the land below him was surveyed by the U.S. Congressional Township Survey System is:
   a. the absence of a consistent rectangular system of roads
   b. the fact that he is flying over quite rugged, mountain terrain
   c. the presence of a consistent rectangular pattern of roads
   d. a and b
   e. none of the above
80, 0.19, 3

58. The U.S. Congressional Township, by definition, consists of:
   a. 1 square mile
   b. 36 square miles
   c. 640 acres
   d. 16 sections
   e. 640 square miles
56, 0.38, 1

59. Which sketch is more correct?
   a. This sketch correctly represents a township
   b. This sketch correctly represents a section
50, 0.27, 3

60. Which sketch is most correct?
   a. b. both sketches incorrectly numbered
   c. this sketch correctly numbered a section of land
96, 0.15, 3
61. The larger the map scale on a map, the greater is the area shown.
   a. True
   b. False
   64, 0.19, 2

62. Contour lines cross streams as V- or U-shaped lines with the closed part of the letter pointing in the direction of stream flow.
   a. True
   b. False
   64, 0.54, 1

63. The following sketch illustrates:
   a. verbal scale
   b. longhand scale
   c. linear scale
   d. representative fraction
   e. fractional scale
   Sketch
   90, 0.31, 2

64. Relief refers to:
   a. the highest point on a given map
   b. the lowest point on a given map
   c. the average elevation on a given map
   d. the difference in elevation between highest and lowest points on a given map or specified area
   e. none of the above
   98, 0.04, 1

65. Contour lines connect points of equal elevation on a map.
   a. True
   b. False
   88, 0.19, 2

66. Contour interval always refers to the vertical distance between contour lines on a map.
   a. True
   b. False
   95, 0.19, 2

67. An enclosed contour line on a map indicates:
   a. the presence of a hill or mountain
   b. the presence of a depression
   c. the presence of a gravel pit
   d. the presence of a church
   e. a bench mark
   75, 0.23, 2
68. A map scale of 1:250,000 indicates that one inch on the map equals approximately or nearly ___ in space or on the earth's surface.
   a. 4 miles
   b. 16 miles
   c. 1 mile
   d. 8 miles
   e. none of the above

69. Which of the following scales is the largest scale?
   a. 1:24,000
   b. 1:62,500
   c. 1:63,360
   d. 1:250,000
   e. 1:1,000,000

70. Each contour line meets and joins with itself on the given quadrangle or on another quadrangle.
   a. True
   b. False

The following ten questions referred to a topographic map.

71. The contour interval of the map is:
   a. 10 feet
   b. 100 feet
   c. 20 feet
   d. 50 feet
   e. 500 feet

72. The elevation of point A is:
   a. 540
   b. 540+
   c. 550
   d. b and c are correct
   e. none of the above

73. The steepest slope is at:
   a. A
   b. B
   c. C
   d. D

82, 0.23, 3
74. The elevation within depression F is:
   a. 500-
   b. 600-
   c. 540
   d. 520+
   e. 520-
   37, 0.50, 3

75. The direction of flow of Lyon's Thing Creek is:
   a. southwestward
   b. northeastward
   c. southeastward
   d. northwestward
   62, 0.50, 3

76. The elevation of point C is:
   a. 480-
   b. 480+
   c. 520+
   d. 540-
   51, 0.15, 3

77. The elevation of the hachured contour line E is:
   a. < 380
   b. 600
   c. 600-
   d. 560
   e. none of the above
   5, 0.15, 3

78. The stream with the steeper gradient is:
   a. Lyon's Thing Creek
   b. the Tributary
   84, 0.12, 3

79. The map scale is 1/2 inch equals 1 mile. Referred to in this fashion, the scale is given as:
   a. verbal scale
   b. graphic scale
   c. representative fraction
   d. fractional scale
   e. c and d
   67, 0.42, 2

80. The elevation of the highest point on the map is:
   a. 700-
   b. 600+
   c. 700+
   d. none of the above
   74, 0.12, 3
Questions 81 - 100 referred to mineral and rock specimens.

81. Specimen number 1 is:
   a. basalt
   b. slate
   c. talc
   d. mica
   e. calcite

82. Specimen number 1 displays:
   a. conchoidal fracture
   b. basal cleavage
   c. rhombic cleavage
   d. even fracture
   e. prismatic cleavage

83. Specimen number 2 is:
   a. talc
   b. conglomerate
   c. rock crystal quartz
   d. quartzite
   e. gneiss

84. Specimen number 2 is a major constituent mineral of:
   a. granite
   b. diorite
   c. gabbro
   d. all of the above
   e. none of the above

85. Specimen number 3 is:
   a. talc
   b. schist
   c. slate
   d. calcite
   e. mica

86. Specimen number 3 exhibits a Mohs hardness of:
   a. 1.0
   b. 2.0
   c. 3.0
   d. 4.0
   e. 5.0

87. Specimen number 4 is:
   a. selenite gypsum
   b. calcite
   c. schist
   d. mica
   e. gabbro
92, 0.23, 3

88. Specimen number 4 exhibits:
   a. brittle tenacity
   b. elastic tenacity
   c. flexible tenacity
   d. all of the above
   e. none of the above
62, 0.35, 3

89. Specimen number 5 is:
   a. marble
   b. gneiss
   c. calcite
   d. granite
   e. diorite
77, 0.31, 3

90. Specimen number 5 must contain the two minerals:
   a. quartz and feldspar
   b. calcite and quartz
   c. calcite and feldspar
   d. gypsum and talc
   e. none of the above
82, 0.38, 3

91. Specimen number 6 is:
   a. diorite
   b. granite
   c. gneiss
   d. schist
   e. gabbro
68, 0.50, 3

92. Specimen number 6 is characterized by a definite lack of the mineral:
   a. feldspar
   b. mica
   c. quartz
   d. all of the above
   e. none of the above
58, 0.69, 3
93. Specimen number 7 is:
   a. granite
   b. basalt
   c. diorite
   d. gabbro
   e. gneiss
   83, 0.15, 3

94. Specimen number 7 is the surface equivalent of:
   a. granite
   b. conglomerate
   c. quartzite
   d. gabbro
   e. gneiss
   53, 0.35, 3

95. Specimen number 8 is:
   a. sandstone
   b. fossiliferous limestone
   c. diorite
   d. schist
   e. conglomerate
   97, 0.08, 3

96. Specimen number 8 is:
   a. an igneous rock
   b. a sedimentary rock
   c. a metamorphic mineral
   d. a metamorphic rock
   e. c and d
   78, 0.27, 3

97. Specimen number 9 is:
   a. oolitic limestone
   b. fossiliferous limestone
   c. conglomerate
   d. gabbro
   e. granite
   85, 0.42, 3

98. Specimen number 9 is of:
   a. chemical origin
   b. organic origin
   c. igneous origin
   d. metamorphic origin
   e. none of the above
   37, 0.54, 3
99. Specimen number 10 is:
   a. shale
   b. schist
   c. sandstone
   d. slate
   e. none of the above
   63, 0.12, 3

100. Specimen number 10 is:
    a. a high rank metamorphic rock
    b. an intermediate rank metamorphic rock
    c. a low rank metamorphic rock
    d. a sedimentary rock
    e. an igneous rock
    34, 0.35, 3

101. A true soil contains:
    a. water
    b. organic matter
    c. mineral matter
    d. air
    e. all of the above
    100, 0.00, 1

102. The A soil horizon:
    a. contains humus
    b. is a zone of illuviation
    c. is a layer often characterized by hardpan
    d. all of the above
    86, 0.23, 1

103. Soil texture:
    a. refers to the arrangement of soil particles
    b. refers to the size of soil particles
    c. refers to the size and arrangement of soil particles
    85, 0.23, 1

104. In which of the following sized soil particles should water retention be the greatest?
    a. large-sized soil particles
    b. intermediate-sized soil particles
    c. small-sized soil particles
    86, 0.15, 3

105. Which of the following terms, by definition, refers to the ability of a soil to transmit water?
    a. porosity
    b. pedosity
    c. permeability
    66, 0.19, 1
106. Black Prairie soils:
a. are located in regions of less than 20 inches of annual rainfall
b. are characterized by an excess of calcium in the A soil horizon
c. are definitely a pedocal soil
d. all of the above
e. none of the above
43, 0.38, 1

107. Pedalfer soils:
a. are rich in aluminum
b. are rich in iron
c. are rich in calcium
da. a and b
e. none of the above
70, 0.19, 1

108. Chernozem soils in the United States:
a. are located on the dry side of the Black Prairie soils
b. are located on the wet side of the Black Prairie soils
c. are inherently quite fertile
da. a and c
e. b and c
49, 0.35, 1

109. Laterite soils form under a vegetative cover of:
a. needle-leaf evergreen trees
b. broadleaf evergreen trees
c. broadleaf deciduous trees
d. tall, coarse grasses
e. short, fine grasses
51, 0.15, 2

110. Chestnut and Brown soils would most likely be found in:
a. Florida, Georgia, and the Carolinas
b. Indiana, Ohio, and Pennsylvania
c. Wyoming, Montana, and Colorado
d. New York, Michigan, and New England
e. all of the above
86, 0.12, 2
Comprehensive Test Questions

As was the case of the unit test questions, the groups of numbers immediately following each question refer to item difficulty, item discrimination, and level of thinking required for each question.

1. The shape of the earth is:
   a. round
   b. an aberrated sphere
   c. an oblate spheroid
   d. spherical
   e. a and d
   83, 0.19, 1

2. Eratosthenes determined the circumference of the earth was about 25,000 miles. He used a sketch similar to the one which follows. If the distance between Alexandria and Syene had been 800 miles, and the latitude between the two cities had comprised 1/40 of a circle, his determination of earth circumference could have been:
   a. 32,000 miles
   b. 200 miles
   c. 5,000 miles
   d. 320 miles
   e. 500 miles
   95, 0.08, 4

3. All meridians:
   a. extend north to south
   b. meet at the poles
   c. extend east to west
   d. parallel one another
   e. a and b
   92, 0.15, 1

4. Greenwich, England is important in mapping because:
   a. it coincides with the prime meridian and is located at 0° longitude
   b. Columbus sailed from there on his trip to the New World
   c. it is located at the 0° point of latitude
   d. a and b
   e. b and c
   79, 0.27, 3
5. The following are great circles (or 1/2 of great circles):
   a. all meridians
   b. all lines which cut the earth exactly in half if a plane
      is passed through them
   c. the equator
   d. all of the above
   e. none of the above
86, 0.23, 3

6. Point B in the sketch is located at:
   a. 2° 30' N, 175° W
   b. 2° 30' N, 175° E
   c. 5° N, 175° W
   d. 2° 30' S, 175° W
   e. 5° S, 175° E

7. The period of earth rotation is:
   a. 24 hours
   b. 365 1/4 days
   c. 30 days
   d. 24 days
   e. none of the above
80, 0.31, 1

8. The direction of earth revolution is:
   a. east to west
   b. north to south
   c. south to north
   d. west to east
   e. varies with the season
74, 0.35, 1

9. The accompanying sketch illustrates the first day of a sea­
   son. What season will follow immediately after the season
   illustrated in the sketch, in the northern hemisphere?
   a. Spring
   b. Summer
   c. Autumn
   d. Winter
31, 0.19, 5

10. Using the sketch of the above question, which pole will be
    nearer the sun the first day of the season after the season
    illustrated in the sketch?
    a. the north pole will be nearer the sun
    b. the south pole will be nearer the sun
    c. neither pole; both poles will be equidistant from the sun
80, 0.35, 4
11. It is March 21st. You are located at 25° N. What is the altitude of the noon sun?
a. 25°
b. 90°
c. 31 1/2°
d. 65°
e. 45 1/2°
62, 0.23, 4

12. If it is 4:00 A.M., Thursday at 122° W, what is the time and day at 122° E?
a. 8 P.M., Wednesday
b. 8 P.M., Thursday
c. 8 A.M., Wednesday
d. 8 A.M., Thursday
e. none of the above
39, 0.19, 4

13. The most significant process by which the earth is heated is:
a. radiation
b. convection
c. conduction
d. all are equally significant
57, 0.31, 1

14. Sea breezes blow during the daytime because:
a. the land heats more rapidly than the adjacent water
b. the water heats more rapidly than the adjacent land
c. higher atmospheric pressures exist over the water than over the adjacent land
d. a and c are correct
e. b and c are correct
61, 0.35, 2

15. The accompanying sketch illustrates:
a. radiation
b. conduction
c. convection[Sketch]
d. none of the above
86, 0.23, 2

16. The weather instrument used to measure wind velocity is the:
a. wind vane
b. aneroid
c. psychrometer
d. hygrometer
e. none of the above
32, 0.62, 1
17. Assume the atmospheric pressure at sea level is 29.92" of mercury. If you are at 1,000 feet above sea level, the atmospheric pressure will be:
   a. higher than at sea level
   b. lower than at sea level
   c. the same as at sea level
58, 0.35, 3

18. The accompanying sketch illustrates a surface area with a temperature of 60° F, A, and two adjacent areas, each 75° F, B and C. Which of the following should hold true?
   a. A will be a high pressure area
   b. B and C will be high pressure areas
   c. winds will blow from B and C toward A
   d. b and c
   e. none of the above
49, 0.58, 3

19. Which of the following are not included in the hydrologic cycle?
   a. condensation
   b. evaporation
   c. precipitation
   d. sublimation
   e. all are included in the hydrologic cycle
58, 0.31, 1

20. The direct return of a substance from a solid to a gas without passing through the intermediate liquid stage is called:
   a. evapotranspiration
   b. evaporation
   c. sublimation
   d. condensation
   e. none of the above
86, 0.31, 1

21. The amount of moisture in the air at a given temperature compared with the amount of moisture the air could hold at that temperature is termed:
   a. humidity
   b. condensation
   c. evapotranspiration
   d. relative humidity
   e. sublimation
95, 0.15, 1
22. In what cloud family does altostratus belong?
   a. low clouds
   b. middle clouds
   c. high clouds
   d. clouds of vertical development
   e. in any of the above-named families

23. In what cloud family does stratocumulus belong?
   a. low clouds
   b. middle clouds
   c. high clouds
   d. clouds of vertical development
   e. in any of the above-named families

24. The accompanying sketch suggests that:
   a. hail may occur at the ground
   b. sleet may occur at the ground
   c. rain may occur at the ground
   d. a and c
   e. b and c

25. Which of the following is not a form of precipitation?
   a. rain
   b. dew
   c. snow
   d. hail
   e. all are forms of precipitation

26. In air mass development, if the surface is warm and moist, the lower atmosphere above the surface will be:
   a. warm and dry
   b. cold and dry
   c. cold and moist
   d. warm and moist

27. Identify the type of precipitation occurring in the accompanying sketch:
   a. orographic precipitation
   b. cyclonic precipitation
   c. convective precipitation
   d. frontal precipitation
   e. none of the above
28. The accompanying sketch illustrates:
   a. a high pressure cell
   b. a low pressure cell
   c. an anticyclone
   d. a and c  
   e. b and c
29. In a warm front occlusion:
   a. the warm front overtakes the cold front
   b. the cold front overtakes the warm front
   c. the front is always stationary
   d. the warm front will leave the surface
   e. a and d are correct
30. The Metes and Bounds survey system:
   a. is based on a rectangular survey system
   b. is based on local landmarks
   c. utilizes 640 acre parcels of land
   d. is commonly used in Indiana
   e. all of the above are correct
31. The symbol Sec. 16 refers to:
   a. 640 acres
   b. 320 acres
   c. 160 acres
   d. 80 acres
   e. 40 acres
32. The section number in the following sketch is:
   a. 26
   b. 24
   c. 30
   d. 36
   e. none of the above
33. A clue to an aerial observer that the land below him was surveyed by the U.S. Congressional Township Survey System is:
   a. the absence of a consistent, rectangular system of roads
   b. the fact that he is flying over quite rugged, mountain terrain
   c. the presence of a consistent, rectangular pattern of roads
   d. a and b
   e. none of the above
34. The U.S. Congressional Township, by definition, consists of:
   a. 1 square mile
   b. 36 square miles
   c. 640 acres
   d. 16 sections
   e. 640 square miles

55, 0.46, 1

35. Which sketch is more correct?
   a. This sketch correctly represents a township
   b. This sketch correctly represents a section.

46, 0.35, 3

36. The larger the map scale, the greater is the area shown.
   a. True
   b. False

84, 0.04, 3

37. Contour lines cross streams as V- or U-shaped lines with the closed part of the letter pointing in the direction of stream flow.
   a. True
   b. False

57, 0.62, 1

38. The following sketch illustrates:
   a. verbal scale
   b. longhand scale
   c. linear scale
   d. representative fraction
   e. fractional scale

86, 0.31, 2

39. Contour lines connect points of equal elevation on a map.
   a. True
   b. False

90, 0.35, 2

40. Which of the following scales is the largest map scale?
   a. 1:24,000
   b. 1:62,500
   c. 1:63,360
   d. 1:250,000
   e. 1:1,000,000

71, 0.23, 3

41. Each contour line meets and joins with itself on the given quadrangle or on another quadrangle.
   a. True
   b. False

93, 0.08, 2
The following five questions referred to a topographic map.

42. The contour interval of the map is:
   a. 10 feet
   b. 100 feet
   c. 20 feet
   d. 50 feet
   e. 500 feet
   58, 0.50, 3

43. The elevation of point A is:
   a. 540
   b. 540+
   c. 550
   d. none of the above
   e. b and c
   73, 0.19, 3

44. The steepest slope is at:
   a. A
   b. B
   c. C
   d. D
   79, 0.31, 3

45. The elevation of the hachured contour line E is:
   a. 580
   b. 600
   c. 600-
   d. none of the above
   9, 0.23, 3

46. The stream with the steeper gradient is:
   a. Lyon's Thing Creek
   b. The Tributary
   86, 0.12, 3

47. A true soil contains:
   a. water
   b. organic matter
   c. mineral matter
   d. air
   e. all of the above
   100, 0.00, 1

48. The A soil horizon:
   a. contains humus
   b. is a zone of illuviation
   c. is a layer often characterized by hardpan
   81, 0.27, 1
49. Soil texture refers to:
   a. arrangement of soil particles
   b. size of soil particles
   c. size and arrangement of soil particles
   76, 0.46, 1

50. Black Prairie soils:
   a. are located in regions of less than 20 inches of annual rainfall
   b. are characterized by an excess of calcium in the A soil horizon
   c. are definitely a pedocal soil
   d. all of the above
   e. none of the above
   28, 0.42, 1
APPENDIX VI

ATTITUDE SCALE

PERMISSION SHEET

ITEMS ON SCALE
Permission to use attitude scale

Permission to use the attitude scale shown on the following pages was obtained through a personal communication with Dr. John R. Cummings in May, 1969.
An Instrument for Measuring Attitudes Toward Science and the Scientist

1. The majority of scientists are irreligious.
2. I am very strongly attracted to scientific activities.
3. More science should be taught in the elementary school.
4. Theories and laws of modern science are apt to remain in their present form.
5. Science has caused chaos in our world.
6. Science is essential in this technological age.
7. Most scientists make few friends other than their fellow scientists.
8. Those girls who are not mechanically inclined should not contemplate becoming scientists.
9. I am enthusiastic about learning more scientific information.
10. Educators attach too much importance to the study of science.
11. Science will enable us to think more clearly in most other subject areas.
12. Science is less interesting than most other school subjects.
13. Scientific methods will find the solutions to our social problems such as crime.
14. Science causes our way of life to change too rapidly.
15. Science aids us in comprehending our surroundings.
16. Scientific work is boring.
17. I would not like to become a research scientist.
18. People possessing creative imaginations should not pursue science as a vocation.
19. Most scientists are little concerned about the harmful consequences of later applications of their research findings.
20. Scientific research problems are intriguing.

21. The study of science enables one to reason more clearly in other areas such as politics.

22. Science has not been very beneficial to the average citizen.

23. Science is a very fascinating subject.

24. High school science ought to be compulsory only for those students who wish to become scientists.

25. Science is irrelevant in present-day society.

26. Scientists have a potent influence over the significant economic, political and social processes.

27. Most scientific investigations are performed in the laboratory rather than in the everyday world.

28. An education in science is imperative in present-day society.

29. Government favoritism toward extraordinary scientific talent is undemocratic.

30. Most scientific research is conducted by scientists who have little concern for their own personal physical welfare.

31. Most scientists are very creative thinkers.

32. Scientific knowledge is hard for me to understand.

33. Science is little related to everyday living.

34. I enjoy solving science problems in the school laboratory.

35. Only students of better than average ability can be successful in school science courses.

36. Science helps society by using recently discovered scientific information to develop new industries.

37. I wouldn't like to pursue a science research program.

38. Scientists' attempts to solve their personal problems of everyday living are often unrealistic.

39. Science information which is not related to school work frequently interests me.
40. An education in science contributes toward good citizenship.

41. The study of science benefits people socially.

42. The methods of science will not enable the human mind to comprehend many aspects of our universe.

43. The methods of science are not applicable to understanding human behavior.

44. A comprehension of the significance of science is necessary to thoroughly appreciate present-day society.

45. Scientists are often eccentric in their personal behavior.

46. Scientific truths are normally discovered by individuals seeking financial gain.

47. I enjoy doing science investigations.

48. The difficulties involved in learning science often exceed its usefulness.

49. To me science classes are very uninteresting.

50. I enjoy doing science laboratory experiments.

51. Great improvement in all areas of human endeavor could be accomplished by the application of scientific methods.

52. Most of the science worth knowing can be read in books.

53. Most scientific discoveries were accidental.

54. A comprehension of science is essential for my everyday living.

55. The majority of scientists are not interested in the practical value of scientific information.

56. The nation's top scientists are mainly interested in their own current thought.

57. Science is chiefly a program of action for originating new gadgets.

58. An education in science frequently helps one make more logical decisions in everyday living.

59. Science is not as important as other school subjects such as English.
60. Science appears to be necessary in our present-day society.

61. Public interest in science is necessary for the continuance of scientific research.

62. In pursuit of their interests, scientists often consent to sacrifice the well-being of others.

63. I would not recommend high school science to beginning high school students.

64. The advancement of science makes possible the control of our lives by a few people.

65. Most great discoveries of the world were found through careful observations rather than by accident.

66. Scientists have shown their lack of consideration for the welfare of mankind by participating in such research as the development of nuclear weapons.

67. I would prefer not to take any college science courses.
BIBLIOGRAPHY

Books


Ball State University. Introducing Ball State. Muncie, Ind.: Ball State University, 1971.


Periodicals


Gennaro, E.D., and Boeck, C.H. "Use of Self-Instructional Car­
rels in Science Teaching." School Science and Mathematics,
68 (February, 1968), 277-278.

Haefele, D.L. "Self-Instruction and Teacher Education." Audio­
visual Instruction, 14 (January, 1969), 63-64.

Hoffman, F.E., and Druger, M. "Relative Effectiveness of Two 
Methods of Audio-Tutorial Instruction in Biology." Journal 
of Research in Science Teaching, 8, no. 2 (1971), 149-156.

Mundt, A.V. "Toward Self-Instruction Practices." Audiovisual 
Instruction, 14 (March, 1969), 86.

Ogston, T.J. "Individualized Instruction: Changing the Role of 
the Teacher." Audiovisual Instruction, 13 (March, 1968), 
243-248.

Popham, W.J. "Objectives '72." Phi Delta Kappan, 53, no. 7 
(March, 1972), 432-435.

Biology Teacher, 32 (January, 1970), 31-33.

Geography, 66, no. 4 (April, 1967), 155-158.

Smith, P.G. "On the Logic of Behavioral Objectives." Phi Delta 
Kappan, 53, no. 7 (March, 1972), 429-431.

Thompson, M.M., and Dressel, P.L. "A Survey of Independent Study 

Torrance, E.P. "Independent Study as an Instructional Tool." 
Theory Into Practice, 5, no. 5 (December, 1966), 218.

Underwood, D.L. "Creativity in Instruction: Florissant Valley 
Community College." Audiovisual Instruction, 12 (Sep­
tember, 1967), 681-682.

Wirth, A.G. "A Perspective for Independent Study." Theory Into 

Wooten, R.D. "Independent Study Curriculum." Improving College 
and University Teaching, 16 (Autumn, 1966), 277-278.

University and College Catalogs

Ball State University. Ball State University Bulletin, 45, no. 1. 
Muncie, Ind., 1970.


Unpublished Materials and Miscellaneous

Ball State University. *General Studies Program*. Muncie, Ind.: Ball State University, undated brochure.

Ball State University. *Interpretive Recommendations for Item and Test Analysis Computer Output*. Muncie, Ind.: Office of Examination Services, undated pamphlet.
