INDEPENDENT STUDY OF COLLEGIATE BIOLOGICAL SCIENCE AS A GENERAL EDUCATION COURSE: INVOLVING ACHIEVEMENT AND UNDERSTANDING THE PROCESSES OF SCIENCE

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CHAPTER I

INTRODUCTION

Instructors of biological science, as a general education survey course on the college level, are faced with an abundance of talented students whose science backgrounds can best be described by one word: heterogeneous. Part of the reason for this diversity in students' science backgrounds is due to the "new science" programs that are offered to some students and not to others. Basic in the new science curricula such as Biological Science Curriculum Study (BSCS), CHEM STUDY, Physical Science Study Committee (PSSC), and Earth Science Curriculum Program (ESCP), to name a few, is the focal idea of developing students in independent thinking and other activities of the autonomous, self-reliant, critical-thinking student.

In an effort to meet the challenges of more and brighter high school graduates as well as others interested in a college education, colleges and universities have planned special programs such as independent study, audio-tutorial, seminars, and advanced placement.

Independent study in its various forms offers one possibility of an instructional approach which, seemingly, could provide a more efficient learning environment for some students as well as yield more efficient use of the instructor time. If some students can attain the objectives of a course with only limited content accompanied by an instructor and with more efficient use of study effort that present approaches make possible, then it should be possible for fewer instructors, using their efforts to better advantages, to provide for an equal or better quality of education for more students.

In addition, by correlation of pre-test information (along with identifying student characteristics) with performance in independent study it might be possible to identify factors which could be sufficiently predictive of success in independent study to warrant advising students to choose this instructional approach.

Conventional methods of college instruction, such as the lecture or lecture-discussion class, which are almost always scheduled within a quarter or semester block of time, allow for at best, only modest recognition of individual differences in learning rate or initial level of knowledge of course content.

The present study is concerned with the effectiveness of one type of independent study as a method of instruction in a biological science course for non-majors at the college level.

The study was conducted as an attempt to develop an instructional approach which would allow the student greater flexibility of learning method and scheduling of individual study time than the conventional lecture-discussion class.

It was hypothesized that if the intended end product of learning in specific courses could be defined for the student and for the instructor, and if the student could then decide with guidance how he could best make use of the resourses of the institution, then some students would be able to attain course objectives more efficiently by studying independently than by conventional classes.

Background of the Study

In any given class of students at any given moment, differences among students in what is known and what is easily learned are vast. Homogeneous grouping on the basis of ability test is of little significant value (11). It appears then that what we must do as educators is to experiment. We must experiment with innovative methodologies which are constructed to meet the needs, interests, and relevancies of the student. Cohen (23) points out:

> Independent study enables students to proceed at their own paces. Many of the faster learners, those who could probably learn well under any instructional form, choose this mode almost exclusively. They are the ones who find that many types of media interrupt their own ways of proceeding; thus, they choose to read and examine on their own. The independent study student seldom has to repeat unit exams. It is apparent that with these students, the specification and communication stimulates them to apportion their time satisfactorily and encourages them to structure their own learning.

More individualized instruction seems called for and indeed most recent developments in education such as the emphasis on better text books, teaching machines, programmed instruction, audio-tutorial instruction, and computer based systems indicate a general movement toward more individualized instruction. This opens up a new dimension of choice to educational planners. That new dimension is the degree to which the learner controls the learning process himself as opposed to our controlling it for him; and this has been the central idea of this research. This experimentation is an attempt to tentatively identify instructional techniques and subject matters of biological science which most effectively utilize the student's capacities for independent study. Cohen (23) advises:

> Curriculum and instruction should be exclusively geared to student achievement. Time is not considered indicative of the student's commitment to or the value of his learning. The student's time is his own; he may spend it on campus or off, in class or at work; reading or listening. The college seeks only student achievement in the form of a tangible product.

If this experimentation contributes data to the identification of what is a better learning situation for students, then we might truly reach the ideal Spiltz (73) suggested when he said:

> The National Defense Education Act, first passed in 1958 and recently extended and expanded, is based on the premise that every American should have the opportunity to develop his skills and competencies to the fullest extent, and that only in this way can the nation develop the trained manpower and insure the leadership essential for the preservation of democracy.

Statement of the Problem

In a sincere attempt to provide a meaningful learning experience for all their science students, college instructors devote much of the lecture and laboratory instruction to the average student. This leaves the slow and fast learners to fend for themselves during the semester; the slow learner "running" to keep up and the fast learner in a "doldrum," waiting for the slow and medium speed learners to reach his level. The question is, "how can a methodology be arranged to challenge each individual in a beginning collegiate general education biological science course?" The purpose of this study is to determine if independent study will contribute to the answer to this question.

A second objective in this study is to determine the characteristics of those students who seem to do best under the independent study exposure. Criteria for these analyses will be accrued by the analyses of the American College Testing (ACT) composite scores, fathers' educational background, and the students' "new" and traditional high school science backgrounds. The Nelson Biology Test Form E and the Test on Understanding Science (TOUS) will be used as the criteria variables.

In summary, the primary purpose of this study is to compare the effects of regular or conventional and independent study methods of instruction on the achievement and understanding of science of the students in an introductory collegiate biological science course.

Hypotheses

The hypotheses for this study are nested and are stated in the null. (15) There is no significant difference in understanding and achievement in biological science between the experimental group and control group in a general education beginning college biological science courses, when the students are taught under the conventional and independent study methods. The hypotheses will be specifically stated and analyzed in Chapter IV.

Significance of the Study

The research reported in this study was to determine the effect of independent study on the student in his achievement and understanding of science. Another purpose of this research was to discover information which would lead toward a more enlightened answer to the question, "how shall we structure a learning situation for all students?"

Recognition of the reality that Independent Study Programs vary considerably in methodology, nature, quality and quantity, it is necessary to explain in explicit terms that justification of this study has been based upon the necessity of identifying a criteria profile of the student group that does well in independent study in biological science. Should this be possible we might extrapolate these student groups data profiles to other general education courses at the collegiate level.

Limitations of the Study

The results of this research may be generalized, but are basically products of those students enrolled in Biological Sciences 1114, during the Spring semester of 1970 at Oklahoma State University.

Students participating in the Independent Study Program were volunteers. Since Independent Study is student-centered and each student is unique in terms of his individualized study activities, patterns, likes and dislikes, adequate testing on understanding of science is difficult if not impossible to construct.

There has been no attempt to evaluate the effectiveness of either the instructors of the traditional lecture or laboratory sections or the instructors directing the Independent Study student groups.

Definition of Selected Terms

Ability

An ability is a series of cognitive processes that are necessary to demonstrate either knowledge and/or understanding of biology.

Achievement

Achievement is a mean gain value derived from a pre-test and post-test sequence of the Nelson Biology Test Form E.

Biological science

Biological science is the beginning or first semester of biology offered at Oklahoma State University for non-major students of biology. The course is designated Biological Science 1114.

College

A college is four year school standing between secondary school and the graduate institution that performs a function differing from the other two.

Conventional science experimental group

All those students who were in the experimental section who had science background from their high school experience which consisted of conventional methodology were called the conventional science experimental group.

Discipline

A discipline consists of a coherent group of interrelated concepts that can be applied to kindred phenomena and that allows one to make theoretical or explanatory statements about the relationships of these phenomena.

General Studies

General Studies refer to the nonvocational and nonspecialized portion of the students educational program.

Independent study

Independent study is defined as behaviors necessary to cover content and to achieve the objectives of a course through reading, work, and discussions conducted over a period of several weeks with or without the presence of the instructor.

Independent study section

The independent study sections consist of students enrolled in the independent study experimental groups.

Instructor

The instructor is who supervises, acts as a resource person, or does a limited amount of teaching. In this study the term is used synonymously with the word teacher.

Learning

Learning is the changed capacity for or tendency toward acting in particular ways.

Liberal Arts Program

An emphasis on the humanities and history and the treatment of the conceptual grounds of knowledge in the sciences and social sciences, as the central core of the college's concern in the Liberal Arts Program.

New science and old science control groups

The "new" science and the "old" science control groups were similar to the experimental groups, however, they are members of the control group.

New science experimental group

All those students who were in the experimental section who had a "new science" course background in high school such as Biological Science Curriculum Study (BSCS), Physical Science Study Committee (PSSC), or others, were called the "new" science experimental group.

Period

The period is the time at which the various sections or classes met in the laboratory or sessions.

Problem solving ability

That capacity to evaluate the peculiarities of a situation in terms of past experience and then to make an intelligent approach to a current problem was recognized as problem solving ability.

Section

Section is defined as students who were enrolled in regular lecture-laboratory conventional biological science 1114 course at Oklahoma State University.

Self-directed study

Synonymous with independent study.

Specialization

A fixed knowledge of a small piece of subject matter through the use of a discipline is known as a specialization.

Subject matter

Subject matter is defined as a related class of phenomena that can be analyzed by a particular discipline.

Traditional instruction

Traditional instruction is recognized as the presentation of a course through separately scheduled lecture and laboratory sessions. The teacher is the dominating force with little direct control being exerted over the student learning experience.

Understanding of biology

A student has an understanding of biology if he can use the facts, laws, theories, and assertions and facts in a context or situation.

Assumptions of the Study

It is assumed that taking responsibility for the direction and the extent of learning is different from the teacher centered traditional lecture method of learning.

Institutions of higher education employing independent study can implement it as an innovative teaching methodology to provide a new learning situation designed to take the student as far as the student's interests and abilities will allow him to progress.

Another assumption of this study is that not very many factors are known about how people learn. It is generally contended that high ability students will generate more effort into defining limited or open-ended objectives.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Introduction

Independent study is not new. The history of independent study is founded in Greek education, manifested in the Oxford Tutorial System in England, and today becoming increasingly more popular with educational institutions in this country.

Confusion between independent study and the honors program is common. Honors programs are called independent study on some campusses. Generally the difference is that independent study programs consist of all or nearly all students, whereas the honors program is typified by a selection of better ability students.

Independent study programs are increasing in numbers throughout higher education. Felder (34) found in a survey of 520 institutions which offer four-year degree programs and have enrollments exceeding two hundred, that 68 percent of the 445 reporting institutions used independent study to some degree.

One reason given for change from the conventional method of "teaching" to the independent study experience is due to the necessity of providing a relevant experience in education for every student. The undeniable need for change in teaching methodologies and for curricular reform is not just for the general education curriculum but for the entire spectrum of courses offered in higher education. Eddy (32) urges curricular rennovation and the upgrading of teaching of teaching as he says:

> We have noted the honest urge on the part of the student for self-discovery, for meaning to his existence. We have talked of his readiness to assume responsibility for his own education, however, if the college is to seek a larger role in the lives of its students, it is obligated to make a greater effort to break from tradition in both form and substance...obviously is necessary. Tradition should not be allowed to stand in the way of constructive change.

Experimentation and curricular transition in higher education comes about rather slowly. Dressel (30) verifys this as he states,

> Because of the entrenched strength of units and individuals who are concerned with maintaining the status quo, much curriculum revision consists of one or two gimmicks rather than a thorough re-evaluation of the existing program.

"Gimmicks" in undergraduate curriculum are commonly due to a shift toward deemphasization of the undergraduate general education. Mayhew (54) points this out as he concludes:

> It is apparent that revised administrative and organizational structure for institutions of higher education is essential for curricular reform. It is possible to visualize revised structure if some principles and guidelines can be developed. In one sense, the obverse of the weaknesses just noted can serve as guidelines. Thus, some agency must assume responsibility for broad educational leadership. In some way or other, the drift toward departmentalism and preoccupation with graduate education must be checked if the needs of undergraduate students are to be accommodated.

The necessity for innovation in instruction in higher education is recognized by Harrold R. Zacharias, Chairman of the Panel on Education Research and Development of the President's Science Advisory Committee as he stated in the committee's report, "the task of educational research and development is to learn how to provide for all students the education an exceptional teacher provides for a few."

The preceding discussion relates to an urgent need for more experimentation in pedagogical techniques and identification of additional opportune learning situations. Independent study is apparently one methodology which seems to have a relevant effect on student and teacher alike. A summary of selected independent study programs elucidate the overall worth of innovative experimentation.

A Brief Survey of Selected Programs of Independent Study

Independent study may occur in a variety of forms, ranging from individually originated research conducted under the direction of an instructor, to a highly directed form of study in which the learner follows a prescribed syllabus or study guide with readings and very limited, if any, contact with instructors. Bonthius and associates (10), have provided extensive reviews of the various approaches to independent study which have been utilized.

Implementation of independent study at Goddard College is spelled out by Chickering (22) as he indicates that when a student engages in independent study, it is his responsibility to initiate, plan, carry out, and evaluate his work.

Goddard College students apply for independent study. In his application the student describes his objectives, the problem he wishes to investigate, the background skills and information necessary to begin the study. His work schedule for the semester and his plans for reporting the progress of his study are also considered. Registration is not complete until his application is approved by an instructor and the dean of the college. Faculty and the supervising advisor or instructors are available for consultation when needed. In this mode of independent study the students experience considerably more freedom than in other independent study models such as offered by other institutions of higher education where their programs might be best described as quasi-independent study.

Leuba (52) in 1965, at Antioch College, pointed out students of his Psychology classes participating in independent study felt small group discussions contributed greatly in terms of relevancy and enrichment.

Independent study at Wooster College is required. Davis and Stroup (28) report conclusions drawn from the Wooster College experimentation. They found independent study is best summarized as "the chance for intensive self-development along lines of the individuals own choosing." They further conclude:

> Independent study programs are expensive, especially required ones. They have drawbacks, yet they evidently have values for students which are highly prized by the teaching profession. They require sympathetic advisors who can direct literary and field research; and empirical projects especially may take undue amounts of faculty time. Equipment, supplies, and library holdings are among the problems which ambitious programs of independent study magnify.

Students of Wooster College evaluated the required independent study program as, "developing the students ability to work resourcefully or creatively on one's own, training in organizing and writing of material, intensive probing into areas of personal interest, learning of research methods in one's field, and preparation for graduate work and close contact with a faculty advisor."

In addition to the above stated programs numerous research reports and journal articles have been published on independent study. Disciplines with which independent study is a part are enumerated as follows: Bohning (9), literature; Brannon (12), Mathematics; Brown (14) Space Science; Carnell (20), Chemistry; Caro (21), General Psychology; Davis (28), Sociology; Delk (29), history; Ford (35), Biology; Haught (42), Russian History; Posthelthwait (64), Botany; Schilling (70), physics; and Berger (7), Languages. Hayward (44) and Schideler (69) discuss general utilization of independent study in various Liberal Arts programs. In summary, the literature revealed numbers of documented cases where independent study has been and is being used either as a voluntary or required part of the college curricular experience. Several general education and specialized education specialists indicate that independent study has a real and/or desireable potential as an innovative teaching and learning methodology.

Contrasting Views of Independent Study

It has been advised by some that nothing can be so good that there isn't a little bad in it. Apparently this adage is true for independent study as well as for other conditions. Kelly (50) maintains we should proceed with caution. Two major problems commonly found in the literature are stated by Kelly: Firstly, not all students are psychologically endowed to accept independent study responsibility. Secondly, instructors in general are not trained to handle independent study students. Instructors have a tendency to teach as they were taught. Almost all instructors were taught under the conventional methodology (2).

Spitzer (73) is skeptical as to the values of independent study, especially the non-directed type. She recommends more extensive research into its values. Marquette (53) is not as skeptical about the values of independent study but concludes it should be a guided or directed experience which stresses student projects, student planning, and close staff guidance.

In reference to language independent study, Bohning (9) states they are either honors courses or special offerings of regular courses with reduced contact hours to meet the needs of individual students. The decrease in class meetings is generally accompanied by an increase in conferences between the student and his instructor. Independent study is generally not a part of the teaching load so that many faculty feel it causes a serious distraction from their own research and regular teaching duties. Davis and Stroup (28) have compiled the most comprehensive list of gripes against independent study. One should keep in mind that these drawbacks are the result of a required independent study program found at Wooster College. Independent study drawbacks are: the work can take an undue amount of time, students can sometimes get by without work, loss of interest in the topic, the ease of procrastination, reduction in the elective courses one can take, inadequate preparation, the compulsory nature of the program, and the inability of some students to profit from the work.

Contrary to what might be implied above there are those like Caro (21) who found in a study of three hundred thirty-five undergraduates that the students performed as well through independent study as in the conventional class situation.

Seemingly, an extremist view was taken by Hyman (47) as he suggested closing all classrooms and go independent study totally. White (80) would find some difficulty agreeing with Hyman since he argues before independent study can be totally efficient we must narrow the gap between available and required library service. Libraries and resource centers often play a central role in independent study.

National trends in increasing enrollments demand according to Tanner (75), new possibilities of accommodating the influx of greater numbers of students. One proposal made by Tanner is contingent on utilizing independent study programs to hold students somewhat more responsible for their own educational pursuits, thereby alleviating some faculty responsibility and pressure. Even though this platitude is utopean in nature more research must be done to verify if the faculty do in fact save time in independent study experiences. Baskin (5) at Antioch initially found the faculty spent more time in conferences, advising, encouraging, directing, and supervising. After the program was established Baskin indicates the faculty may be freed from some normal instructional time.

Tanner (75) further envisions the independent study program as basically a method of reducing the number of hours a student would be required to attend formal classroom instruction. He would independently, pursue special problems, perform research, do readings, and the writing of position papers on assigned or selected materials. The advantages of independent study are twofold: firstly, a more effective utilization of teaching personnel and, secondly, the improvement of the educational process at the undergraduate level.

There are those in higher education today that maintain students are lost in the masses of large classes. For example, Oklahoma State University enrolls from 250 to 300 students per class in Biological Science 1114. Larger class size seems to be a trend common to almost all higher education. Pommer (62) is concerned about the impact of large classes on the student. In his article "For Better Minds and Smaller Classes," published in the Association of American Colleges Bulletin, December 1956, he declared two goals of higher education should be to "...encourage the student toward more independent study involvment and to free them from disadvantages of large classes. Independent Study would help achieve both goals. Faust, too, is concerned about rising enrollments as well as effective use of faculty resources. To improve the effectiveness of education the author suggests several ideas including independent study (33). It has been projected by 1975 there will be nine million enrolled in college.

McKeachie (55) in reviewing the research related to the efficiency of independent study procedures, has concluded generally that the more student centered methods of learning, including independent study, tend to encourage greater gains in insight and problem solving skills, and tend to promote more attitudinal changes than the comparable instructor centered approaches. The Koening and McKeachie (51) study adds to McKeach's findings as it revealed that "students who fear failure prefer familiar well-structured situations such as lecture."

More independent study experiences are necessary in higher education according to Bohning (9). He said,

> A recent survey of the status of independent study in a modern language department revealed nearly universal recognition of the desirability

> of increasing the responsibility of mature students: ...students must be encouraged to participate more actively in their own education."

Giving the student the responsibility for his breadth and depth of education is encouraged by Chickering (22) as he points out "many students who have shown little promise during the first few semesters, sound their 'own true depth' when permitted to investigate a field of special interest."

A typical independent study student is described by Bohning (9)

> ...the honors man frequently turns out to be the seemingly average boy of the freshman and sophomore year who never would have dared propose himself for anything beyond routine class work and whom the faculty might have rejected as unpromising honors material.... His final hard won laurels often come as a shock to him and to his companians. But this shock is a wonderful thing to watch when it happens. It can be one of the honest triumphs in education. And the student to whom it happens will feel its force for the rest of his natural life.

The structure and composition of independent study varies through out institutions of higher education. Certain studies have eliminated classes for a period of time during the term, some have established some form of tutoring, and others have eliminated all student instructor contact. None of these efforts have demonstrated consistantly the importance of teacher contact or of formal structure (conventional) as a primary determinant of student achievement.

In summary, although considerable research has been conducted with various instructional approaches, the superiority of independent study as a method of instruction has not been demonstrated unequivocally. This contention can be verified as the literature yields conflicting results in the comparison of independent study with teacher centered methods. From the literature reviewed conflicting results were found by Briggs (13), Pressey (66), Russell (68), McKeachie (55), Thompson and Tom (76), Hunnicutt and Iverson (46), Olson (59), and finally, Anderson (4).

Survey of Selected Independent Study Program Conclusions

Investigation of independent study at Antioch College indicates that students at various levels of ability profit significantly from working independently (3). Similar conclusions are reached by Bonthius in reviewing programs of independent study throughout the United States (10).

It has been suggested that the factors determining success in independent study are related to attitudes, motivation, and other personality traits, rather than to academic ability alone (3). However, no consistant significant relationships have been disclosed between personality variables and student achievement or acceptance of independent study.

Baskin's evaluation of the Antioch study indicates that independent study may not be a new method of instruction which will be a panacea for higher education's tandum problems of quality and quantity. A major significance is that independent study has tapped an oft times unused potential for learning, that being, the more direct responsibility the student must take for his own learning.

Two theories concerning where or when independent study should be offered exist. Shideler (69) in 1934, writing in the <u>Journal of Higher Education</u>, suggests independent study should be only for qualified juniors and seniors. His advise seemingly was well heeded since 30 years later, Felder (34) found in his survey of independent study practices in Colleges and Universities, that over half of the colleges surveyed do not grant freshmen and sophomores independent study privileges. During the junior and senior years most of the colleges surveyed, allowed students to complete at least twenty percent of their work by independent study.

Delk (29) in 1965 compared the effectiveness of independent study as compared to the conventional method of study at Washington State University. His data show that there were no significant differences in interest and knowledge between the groups participating in the study.

Independent study students of Antioch College under the direction of Leuba (52) felt independent study is enriched when supplemented by small group discussions in their General Psychology classes.

Recommendations for More Independent Study Programs

"Needed: New Life in the Colleges," written by Jackson (49) in 1929, for School and Society, is very applicable in terms of suggestions and encouragement for more independent study in higher education. Jackson maintained that, and research bares out today, that student independent study or self-study contributes to intellectual maturity (61). Interestingly enough, Jackson called for more independent study at a time when (1929) neither huge enrollments nor the information explosion were major concerns as they are today in education. He projected the following guidelines:

> The plan imposes on each student a large personal responsibility for intensive cultivation of a self-defined, sufficient area of learning, entered upon consciously after he has reached sufficient intellectual maturity in college; instead of the

> existing college characteristics of less intensive and more irresponsible and disjointed cultivation of a similar area, or perhaps only a touch of cultivation of a similar harvest from the plan proves to be increased intellectual power, mental-fertility, charm, resourcefullness, reliability and steadfastness of purpose.

A unique type of independent study program is being tried experimentally at Colby College. Strider (74), writing in Liberal Education, in October, of 1962 explains their program as:

> At Colby College the entire student body spends the month of January investigating topics of their choice. Small-groups exploring the same topic, met with instructors as necessary. Papers submitted at the end of the period were evaluated by the staff.

Wilson (79), Brown (14), Jackson (49), and others, recommend more experimentation with a modified tutorial plan, with suggestion, encouragement, and appraisal for directed independent study. Allan (3) said instruction should be individualized and resource centers must be provided for independent study. Trump (78) joins the ranks of educators for directed independent study as he projects a description of tomorrow's schools in which students will spend approximately forty percent of their time in that type of instruction. Lewis B. Mayhew in the SREB Research Monograph published in 1969, advocates (54):

> Every student should have the opportunity to engage in independent study in which he sets his own goals, proceeds at his own rate, decides when he has finished, and feels free to use or not use professiorial resources the institution provides. This independent work should not be confused with a scheduled tutorial arrangement, where the volition seems to rest with the professor. Rather, it should be the opportunity for students to succeed or fail on their own terms.

Petrich (61) and Hatch (40) declare independent study is necessary for the development of a creative mind. Hatch (40), coordinator of New Dimensions in Higher Education, said the individual study program should be designed for most, if not all students during their freshman year. Furthermore, it should be flexible, emphasizing generalization, use critical thinking, and in some cases involve the teacher in some degree other than as the center of the learning situation.

The results of previous investigations indicate that some students learn more efficiently by various forms of independent study than by traditional classes (22). Independent study in some forms result in the reduction of instructional and learner time with no loss in level of learning, and in addition, may allow a shifting of instructional effort to subtler objectives than the dissemination of information inherent of the conventional methodology (75).

Summary

The effects of independent study other than the learning of course material could lie in the so-called "collateral learning" of critical and independent intellectual attitudes. The most uniform findings of research in this area is that students dislike greater responsibility but come to accept it in the course of a semester, and their brief experience with self-directed study does produce a more favorable attitude toward independent intellectual work. This result was summarized by McKeachie, and et al, in 1962.

Campbell (19) concludes the most field studies of independent study show:

> ...that in no experiment did independent study have adverse effect on learning. This economically quite important, for if there is nothing to be lost in learning efficiency; self direction could save a good deal of time and money. Learning efficiency too might show greater gains over a period of years than we have demonstrated in our brief experiments, at least for students who are motivated to learn...the cumulative effect on his problem solving, decision-making, and creativeness might be impressive.

Many investigators have suggested new methodologies for teaching, education, and learning. None have been more articulate than Woolton (79) as he said, "the student should have available a "cafeteria" of many types of learning experiences from which he may select a menu of learning according to his particular needs."

Finally, since conclusions on the feasibility of independent study vary it is the hope of this investigator that the results of this study will elucidate or clarify current thinking of independent study especially as a learning model in a general education course such as biological science.

CHAPTER III

METHOD AND DESIGN

Introduction

This study is an attempt to determine what the effect of the individual study method of instruction and the lecture method of instruction will have on the achievement and understanding of science on randomly selected groups of volunteer students enrolled in the first semester, general education biology course, Biological Science 1114. The second objective relevant to this research is to determine characteristics of specific students, based on known data from student profiles, who do well in Independent Study. Thirdly, this study attempts to test the feasibility, as an innovative methodology, of independent study as related to the non-biology majors.

Design of the Study

Students in a first semester biology course were asked to fill out a questionnaire (Appendix A) during the first week of the Spring semester of 1969-70. The primary purpose of the questionnaire was for compiling student data profiles (Appendix B) as well as identifying those who would or would not be interested in participating in the independent study program. Questionnaire data were synthesized on the basis of student characteristics such as composite scores from the American College Testing Program (ACT), conventional and "new" science high school background experience, student's sex, father's highest formal educational attainment, and whether the student desired to be a part of the independent study program. Further, the names of students who volunteered for independent study were stacked according to similar data characteristics gathered by the questionnaires. Each student questionnaire was assigned a number, then a table of random numbers was used to select the stratifyed random sample for the independent study groups. Selection of the control group was accomplished following the same technique.

Setting of the Study

The course Biological Science 1114 is a four semester-hour general biology experience offered at Oklahoma State University primarily for non-biology majors. The lecture session classes meet three fifty minute periods per week and one one-hour and forty minute session per week for laboratory.

The content of the course consists of the first fourteen chapters of a textbook entitled Life: An Introduction to Biology, Second Edition, by Simpson and Beck (71). Chapter headings are as follows:

Chapter 1. The Living World and Its Study
Chapter 2. Molecular Aspects of Biology
Chapter 3. The Cell: Unit of Life
Chapter 4. The Cell: Its Metabolic Machinery
Chapter 5. Reproduction: Cellular Aspects
Chapter 6. The Chromosome Theory of Heredity
Chapter 7. Genes and Their Action
Chapter 8. Development
Chapter 9. Reproduction: Organismic Aspects
Chapter 10. Organic Maintenance: I
Chapter 11. Organic Maintenance: II
Chapter 12. Organization and Integration
Chapter 13. Responsiveness
Chapter 14. Behavior

The laboratory manual being used is Laboratory Outlines in Biology, by Abramoff and Thomson (1), from which, with certain modifications, the following weekly laboratory schedule is arranged:

First week	Introduction to the Laboratory
Second week	The Microscope (Chapter I)
Third week	Cells and their Organization (Chapter 2)
Fourth week	Physical Aspects of Life (Chapter 5)
Fifth week	Chemical Aspects of Life (Chapter 6)
Sixth week	Mitosis (Chapter 2)
Seventh week	Meiosis and Genetics (Chapter 12)
Eighth week	Genetics (continued)
Ninth week	Animal Development (Chapter 13)
Tenth week	Photosynthesis (Chapter 7)
Eleventh week	Respiration (Chapter 9)
Twelfth week	Digestion (Chapter 8)
Thirteenth week	Coordination (Chapter II)
Fourteenth week	Biological Transport (Chapter 10)
Fifteenth week	Final examination

A study guide by Humphrey, Van Kyke and Willis, Student Guide for Life, Second Edition, was suggested as optional reference material for the course.

During the Spring of 1969-70 there were approximately seven hundred fifty students enrolled in Biological Science 1114. Lecture sections averaged about two hundred and fifty students in size. There were twenty-five laboratory sections and students were required to enroll in a laboratory section if they were not part of the independent study program (officially the independent study students enrolled in the registrars office for a laboratory section).

Students participating in this study were under the supervision of one instructor, Mr. Benjamin Frye. The administration, planning, conferences, and evaluations were in conjunction with the instructor and the investigator. The responsibility of the laboratory sessions was between eight undergraduate and graduate assistants. The investigator was one of the graduate assistants during the Spring semester.

Laboratory assistants and lecturers had the responsibility of presenting subject matter in the lecture section, prepare and discuss laboratory investigations, and provide opportunity for other experiences related to the course. They each constructed separate tests on the format of their choosing. The laboratory topics were related to topics developed in the lecture sections. The above course description was the educational experience the control group followed.

The students enrolled in Biological Science 1114 come from several of the colleges of the University. The majority of the students were enrolled in the College of Arts and Sciences and were members of the freshmen class.

In this study the population was selected from approximately five hundred students enrolled in sections I and II of the course. Extreme care was taken to insure randomization. Of the initial number of students enrolled in two lecture sections one hundred twenty two elected independent study and three hundred seventy eight indicated they preferred the conventional lecture class. Thirty three students were randomly selected on the bases previously described for the control from the three hundred seventy eight population which followed the conventional lecture class experience. Sixty six students were randomly selected from the one hundred twenty two who elected independent study.

The experimental group of the independent study program did not attend regular lecture or laboratory. The independent study students followed this suggested schedule:

1. General Assembly Session. All students scheduled one hour per week to attend this session where almost all achievement evaluations were administered. During this time class activities consisted of discussing problems of individual students, or other conflicts pertinent to the fulfillment of independent study. This session was also used to discuss current problems of society such as population explosion, venereal disease, birth defects, genetic code, pollution, and other topics of student interest. The students attended this session for only as long as necessary to accomplish what the session is intended (this was not a traditional lecture or laboratory period).

2. Small Assembly Session. The purpose of this session is to provide a closer interaction between the instructor and the student. This session was open to anyone who wanted to come. The session was held on the last day of the week and the student could stay a few minutes or up to three hours, which ever he thought was necessary.

3. Independent Study Session. Students arranged this session at a time and place of their own choosing. It was to be utilized to work on the assigned materials, read research in the library, and to pursue individual literature research for project papers. Other students became involved in laboratory experiments or projects.

4. Evaluation Session. This session was held in the regular laboratory room at the regular time the General Assembly Session met (for most students). Students were permitted, within reason, to proceed in taking tests (evaluations) at their own pace. The course outline was followed in evaluations as well as the quasi-criteria for measurement. On some occasions outside reference materials were used during the evaluation. On one unit evaluation students were allowed

to work in teams composed of four members. Extraneous reference material, discussion, and close cooperation was engendered by the students in making the appropriate response to questions on the evaluative form (test). The student was expected to persist until mastering a specific attainment for each of the five units.

The preceding sessions were formulated with the ideas in mind that the students should proceed through stated objectives at his own pace, during his own time, and at his own place of study. Students were encouraged to feel free to contact the instructor at times when conflicts arose or on other special occasions.

Control group evaluations were effectuated according to the conventional schedule. Independent study groups were evaluated every two or three weeks depending on the length and complexity of the material stated in the syllabus. During the general assembly sessions independent study students who were not ready to take the scheduled performance evaluation or wanted to take accelerated evaluations signed an appointment sheet for an appropriate time which dovetailed into their schedule. During the semester, five evaluations were administered. There was no final test. Students who hoped to receive an A or B were required to do five independent research papers. One research paper was to be handed in at unit testing time. If no independent research had been handed in, and other criteria as described above had been met, the grades were determined on these bases: the grade would not be higher than a B if he had an A average, or a C if he had attained a B average. If independent research had been completed, the instructor would determine whether this research had been sufficient in quality to qualify for the A or B. Students with C and D could do independent readings with the instructor's permission.

Student research was generally one of two forms. The students could elect to experiment in laboratory or field research, or do research in the library. Reports were to relate to the unit under study and preferably to cover materials dated from 1965-70. In terms of library research, reports or projects were selected by the student or suggested by the director of this study. Each paper was constructed as a summary of the summary basis. This means, if the student wrote a ten page report as the first summary a synthesized summary of approximately one page or less would follow.

Tests and Rational for Testing

The Test on Understanding Science (TOUS) was administered in a pretest sequence during the week of January 26, 1970, to the control and experimental groups. The Test on Understanding Science (TOUS) and the Nelson Biology Test, Form E, as post-tests, were used to collect posttest data on each group. These instruments were administered to both groups during the week of May 11, 1970.

The instruments used in this research are reliable and have been used by other investigators in attempts to measure achievement and understanding science in science education.

The revision of the Nelson Biology Test in 1965, was conducted in accordance with the standards established by the Committee on Test Standards, American Educational Research Association and the National Council on Measurements Used in Education.

An item-tryout and a standardization of the proposed test items were conducted in the Spring of 1964 in a carefully supervised research program involving 7,125 students of twenty-seven different schools in twenty-one states, representing geographically balanced regions of the United States. Reliability coefficients for the Nelson Biology Test have been determined by the split-half method and are further amplified by the standard errors of measurements. A sample of 3,540 subjects was administered Form E of the Nelson Biology Test. The arithmetic mean was 30.8 with a standard deviation of 12.3. The split-half reliability coefficient corrected by the Spearman-Brown Prophecy Formula was 0.92 and the standard error of measurement was 3.5 (57).

In the item construction of this test, the author has followed the suggestion of Bloom and others who have proposed that the three major cognitive areas--Knowledge, Comprehension, and Application--were sufficient in scope to measure the important general objectives of instruction.

Sixty-five test items were selected by Nelson, using as criteria the frequency of their inclusion in current science education materials and recommendations by notable experts in the field of science education. Table (I) provides an item classification of the Nelson Biology Test, Form E in the cognitive and content categories, and this distribution of items provided the basis for testing hypotheses (57).

Another criterion instrument for the main analyses is the Test on Understanding Science Form W (TOUS), published by Educational Testing Service. TOUS yields a total score and three scale scores, which measure understandings about the scientific enterprise, scientists, and the methods and aims of science. An introduction to TOUS and the

TABLE I

ITEM CLASSIFICATION OF THE NELSON BIOLOGY TEST, FORM E

Content	Objective: Knowledge	Understanding	Application
Living Things			
Characteristics, Cellular and Molecular Structure, Classification and Grouping	1,9,27,38, 53,56	8,42,55,58, 63,64,65	20,46,47,48, 49
Life Processes			
Human Health and Functions 1	3,26,41,51, 52	25,59,60,61, 62	11
Plant and Animal Life	10	17,18,19,22, 23,44	24,28
Life Cycles, Reproduction, Heredity, and Biological History	29,40	6,39,50,54	7,30,31,32, 33,34,35,36
Ecological Relationships			
World Biome, Natural Resources, and Conservation	2,4	5,21,37,43	45
Methodology and Research			
Experimental Reasoning, Procedures, and Terminology		57	12,13,14,15, 16

[94] Nelson, op. cit., p. 4.

basic rational for this test follows.

Inasmuch as a large variety of tests has been prepared to measure student achievement in facts and principles of science, as of the present time no adequate instrument has been constructed to assess the extent to which the important instructional outcome of understanding science and scientists has been ahcieved (25). It has been pointed out by the authors of TOUS that:

> Numerous studies of science curriculum methods assert that a particular technique or procedure has contributed to these understandings of the student, but, in the absence of valid instruments, such judgments cannot be made objectively to any extent. It is the purpose of TOUS to meet this demand.

TOUS is composed of three major areas:

Area I -Understandings about the scientific enterprise.
Area II -Understandings about scientists.
Area III-Understandings about the methods and aims of science.

The following is a summary of the themes for which specifications were developed as a basis for TOUS (25):

Area I - The Scientific Enterprise.

Theme 1. Human element in science.
Theme 2. Communication among scientists.
Theme 3. Scientific societies.
Theme 4. Instruments.
Theme 5. Money.
Theme 6. International character of science.
Theme 7. Interaction of science and society.

Area II - The Scientist

Theme 1. Generalizations about scientists as people.
Theme 2. Institutional pressures on scientists.
Theme 3. Abilities needed by scientists.

Area III - Methods and Aims of Science

Theme 1. Generalities about scientific methods.
Theme 2. Tactics and strategy of sciencing.
Theme 3. Theories and models.
Theme 4. Aims of science.
Theme 5. Accumulation and falsification.
Theme 6. Controversies in science.
Theme 7. Science and technology
Theme 8. Unity and interdependence of the sciences.

The reliability of TOUS Form X test was collected from 2,535 students. The results of this analysis is as follows:

Scale	Reliability
Area I	.58
Area II	.52
Area III	.58
Total	.76

The reliability for the total score yields a standard error of measurement of 3.49. The arithmetic mean was 32.35 with a standard deviation of 7.38.

The TOUS instrument is in a final standardization stage. It was originally intended for secondary science students in measurement of understanding of science, however, it has been effectively used by other investigators in science education research in higher education. Cognizant of this fact, until normalization data has been compiled for other levels of education the authors recommend the use of tentative norms as temporary guidelines. To further clarify using these norms, the following cautions must be considered: (reprinted from the "Manual of Directions for the Cooperative Tests").

> It should be kept in mind that these statistics report only the performance of the groups on which the statistics are based. Other groups may perform differently. It is therefore, important to remember that norms do not by themselves set standards of performance. In interpreting test scores in comparison with

> such data, allowance must always be made for dissimilarities of the groups and their environments. Standards of performance can be established only by those who are in a position to make a professional judgment of the desired quality of performance of the particular group in particular circumstances.

In the present research problem TOUS is used to determine whether or not differences in teaching procedures inherently found in conventional teaching or independent study can explain a significant portion of the criterion variance. If this in effect can be determined this test could be useful in developing teaching materials and procedures capable of imparting those understandings.

Implementation of the Study

During the initial encounter with the independent study students provisions were made for student's use of designated laboratories, laboratory materials, equipment, and other special materials. Further, preparations were made to use any or all overhead projection, 35 mm slides and projectors, prepared microscope slides, models of various organisms, biologically prepared specimens, and other extraneous materials which were part of Biological Science instruction. Efforts were made to cultivate interest for biological science by making syllabus objectives applicable to living situations during times when discussions, questions, or answers by the class or instructor, were in progress. Cultivation of thought, ideas, and other cognititive endeavors through processes such as attention, inquiry, comparison, and discrimination were encouraged in an effort to understand and possibly modify the environment in which the student lives.

The students were encouraged to use the library for seeking answers to questions and concepts, as well as for doing their research papers. Resource people, public conferences, and interviews were also used for relevant research paper material. Few attempts were made by the instructor to assign or suggest materials, since it was felt that the student should have as much freedom in the selection of a topic as he desired.

To supplement individual research on the topics of the syllabus hand-out sheets were given to the students. Materials on the hand-out sheets consisted of useful prefixes and suffixes, branches of biology (partial listing), selected vocabulary and symbols useful in genetics, and terms relative to mitosis and meiosis.

The independent study students of this experiment followed this schedule during the Spring of 1970 in the course Biological Science 1114.

January 26-30	Introduction-Randomized selection-Testing
February 2-13	Unit I
February 16-20	Evaluation and research due
February 23-March 13	Unit II and III
March 16-20	Evaluation and two research papers due
March 30-April 10	Unit IV
April 13-17	Evaluation and research due
April 20-May 1	Unit V
May 4-8	Evaluation and research due
May 11-15	Standardized test
May 18-22	Catch-up week

Summary

This chapter was concerned with a description of the course, Biological Science 1114, the student enrollment, and the bases for securing a stratified random sample of students who would constitute the experimental and the control groups, as well as what type biological science experience was to be provided for each group.

Further, descriptive analyses and rationale of the two instruments were reviewed. The logistics of this chapter were constructed in an effort to test the heirachial hypotheses relevant to this study.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

Introduction

The primary purpose of this study was an attempt to determine the effects of conventional and independent study treatment on student's achievement and understanding of science. A second purpose was to elicit information on the types of students that do well in an independent study as an innovative methodology in effectuating objectives of the general studies course, first semester introductory Biological Science 1114. This chapter will present the statistical tests and analyses by these tests relative to the study.

Statistical Techniques

The analysis of variance for factorial design is an appropriate statistical technique to test the hypotheses postulated in Chapter I. A significance level of .05 is required for rejection. Equality of cell size was accomplished randomly until all cells had the same number of students subjected to the main effect variables and the criteria variables.

The Ducans Multiple Range Test was employed to test the difference between means where a multiple comparison was necessary.

Methods and Procedures

This study was conducted during the second semester of the academic year, 1969-70 at Oklahoma State University, Stillwater, Oklahoma. The sample was selected from a population of approximately 500 students enrolled in Sections I and II of Biological Science 1114. There were 122 students who elected the independent study program and 378 students who indicated that they preferred the conventional lecture class experience. There were 66 students randomly selected from the 122 students who elected independent study. There were thirty three students randomly selected from the group of students who preferred the conventional lecture class experience.

The Test on Understanding Science (TOUS) was administered in a pre-test sequence during the week of January 26, 1970, to the control and experimental groups. The Test on Understanding Science (TOUS) and the Nelson Biology Test, Form E, as post-tests, were used to collect post-test data on each group. These instruments were administered to both groups during the week of May 11, 1970.

Testing of the Hypotheses

This section presents the analysis of variance of the results attained by the experimental and control groups. The sequence of this presentation of results pertain to the nested hypotheses as stated in Chapter I. However, the nested hypotheses are dealt with in more specific terms concerning the control and experimental groups.

Hypotheses I, II, and III

I. There is no significant difference (.05 level) in achievement between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the Post-Nelson Biology Test.

II. There is no significant difference (.05 level) in achievement between sex as measured by the mean scores on the Post-Nelson Biology Test.

III. There is no significant interaction (.05 level) between sex and treatment as measured by the mean scores on the Post-Nelson Biology Test.

Table II reveals the two-factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 2.07 and 0.04, neither of which were significant at the level of confidence set for this study. There was no significant interaction between sex and treatment. The hypotheses I, II, and III were sustained. This indicated that male and female students do as well in independent study as they do in the conventional lecture experience.

TABLE II

ANALYSIS OF VARIANCE OF THE POST-NELSON BIOLOGY TEST MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND SEX

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	3239.47	47	98.43	
Treatment	136.69	1	136.69	2.07
Sex	2.52	1	2.52	0.04
Sex X Treatment	3.52	1	3.52	0.05
Error		44	65.89	

* Significant at the .05 level.

Hypotheses IV, V, and VI

IV. There is no significant difference (.05 level) in initial understanding of science between the Control and Experimental students as measured by the mean scores on the Pre-TOUS.

V. There is no significant difference (.05 level) in the initial understanding of science between sex as measured by the mean scores on the Pre-TOUS.

VI. There is no significant interaction (.05 level) between sex and treatment as measured by the mean scores on the Pre-TOUS.

Table III indicates the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 2.52 and 0.37 neither of which were significant at the level of confidence set for this study. There was no significant interaction between sex and treatment. The hypotheses IV, V, and VI were sustained. This indicated that the students who participated in this study had similar backgrounds in understanding about the scientific enterprise, about scientists, and about the methods and aims of science as measured by the total Pre-TOUS mean scores.

TABLE III

ANALYSIS OF VARIANCE OF THE TOTAL PRE-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND SEX

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	3942.81	47	126.93	
Treatment	196.02	1	196.02	2.52
Sex	28.52	1	28.52	0.37
Sex X Treatment	58.52	1	58.52	0.75
Error		44	77.88	

Hypotheses VII, VIII, and IX

VII. There is no significant difference (.05 level) in the treatment control and experimental groups as measured by the mean scores of the Post-TOUS.

VIII. There is no significant difference (.05 level) between sex of control and experimental groups as measured by the mean scores of the Post-TOUS.

IX. There is no significant interaction (.05 level) between sex and treatment as measured by the mean scores on the Post-TOUS.

Table IV presents the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 0.89 and 0.14 neither of which were significant at the level of confidence set for this study. There was no significant interaction between sex and treatment. The hypotheses VII, VIII, and IX were sustained. This indicated that the control and independent study students performed equally well in understanding about the scientific enterprise, about scientists, and about the methods and aims of science as measured by the total Post-TOUS mean scores.

TABLE IV

ANALYSIS OF VARIANCE OF THE TOTAL POST-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND SEX

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2375.66	47	58.47	
Treatment	44.08	1	44.08	0.89
Sex	6.75	1	6.75	0.14
Sex X Treatment	0.33	1	0.33	0.01
Error		44	49.46	

Hypotheses X, XI, and XII

X. There is no significant difference (.05 level) between treatments as measured by the mean scores on the Pre Area I TOUS minus the Post Area I TOUS.

XI. There is no significant difference (.05 level) between sex as measured by the mean scores on the Pre Area I TOUS minus the Post Area I TOUS.

XII. There is no significant interaction (.05 level) between sex and treatment as measured by the mean scores on the Pre Area I TOUS minus the Post Area I TOUS.

Table V reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 1.51 and 0.92 neither of which were significant at the level of confidence set for this study. There was no significant interaction between sex and treatment. The hypotheses X, XI, and XII were sustained. This indicated that male and female students participating in this study scored equally well on the pre minus the post TOUS Area I. Area I of the TOUS is designed to test the student's knowledge and understanding of the scientific enterprise.

Hypotheses XIII, XIV, and XV

XIII. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups, as measured by the mean scores of the Pre Area II TOUS minus the Post Area II TOUS.

XIV. There is no significant difference (.05 level) between sex as measured by the mean scores on the Pre Area II TOUS minus the mean scores on the Post Area II TOUS.

TABLE V

ANALYSIS OF VARIANCE OF THE PRE MINUS THE POST TOUS AREA I MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND SEX

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	223.92	47	5.54	
Treatment	6.75	1	6.75	1.51
Sex	4.08	1	4.08	0.92
Sex X Treatment	4.08	1	4.08	0.92
Error		44	4.45	

XV. There is no significant interaction (.05 level) between sex and treatment as measured by the mean scores on the Pre Area II TOUS minus the mean scores on the Post Area II TOUS.

Table VI reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 0.29 for treatment and 5.64 for sex. There was no significant difference in treatment or interaction but there was a significant difference in sexes participating in the two treatments. A visual inspection of the means of the male and female students disclose that the female students scored better on the Post Area II TOUS than did the male students. The female students attained a mean score on the TOUS that was 1.82 better than the male students. These data seem to indicate that female students develop more understanding about the scientist and the roles of the scientist irregardless to whether they are participating in independent study or the conventional lecture method, than do the male students participating in the same experience. Hypotheses XIII and XV were sustained. Hypothesis XIV was rejected.

TABLE VI

ANALYSIS OF VARIANCE OF THE PRE MINUS THE POST TOUS AREA II MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND SEX

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	379.00	47	4.25	
Treatment	2.08	1	2.08	0.29
Sex	40.33	1	40.33	5.64*
Sex X Treatment	0.75	1	0.75	0.11
Error		44	7.15	

* at 0.05 level

Hypotheses XVI, XVII, and XVIII

XVI. There is no significant difference (.05 level) between treatments as measured by the mean scores on the Pre Area III TOUS and the mean scores on the Post Area III TOUS.

XVII. There is no significant difference (.05 level) between sex as measured by the mean scores on the Pre Area III TOUS minus the mean scores on the Post Area III TOUS.

XVIII. There is no significant interaction (.05 level) between sex and treatment as measured by the mean scores on the Pre Area III TOUS minus the Post Area III TOUS mean scores.

Table VII reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 1.92 and 0.51 neither of which were significant at the level of confidence set for this study. There was no significant interaction between sex and treatment. The hypotheses XVI, XVII, and XVIII were sustained. This indicated that male and female students participating in this study scored equally well on the pre minus the post TOUS Area III. Area III of the TOUS is designed to test the student's knowledge and understanding of the methods and aims of science.

TABLE VII

ANALYSIS OF VARIANCE OF THE PRE MINUS POST TOUS AREA III MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND SEX

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	451.98	47	5.89	
Treatment	17.52	1	17.52	1.92
Sex	4.69	1	4.69	0.51
Sex X Treatment	0.52	1	0.52	0.06
Error		44	9.13	

Hypotheses XIX, XX, and XXI

XIX. There is no significant difference (.05 level) in achievement between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the Post-Nelson Biology Test.

XX. There is no significant difference (.05 level) in achievement between students whose fathers had college and whose fathers had no college as measured by the mean scores of the Post-Nelson Biology Test.

XXI. There is no significant interaction (.05 level) between the student's father's educational background and treatment as measured by the mean scores on the Post-Nelson Biology Test.

Table VIII reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 0.008 and 4.06 neither of which were significant at the level of confidence set for this study. There was no significant interaction between father's educational background and treatment. The hypotheses XIX, XX, and XXI were sustained. This indicated that male and female students had mean gain scores in science achievement that were not significant.

TABLE VIII

ANALYSIS OF VARIANCE OF THE POST-NELSON BIOLOGY TEST MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND FATHER'S EDUCATION

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2188.00	31	42.05	
Treatment	0.50	1	0.50	0.008
Father's Education	253.13	1	253.13	4.06
Father's Education - X Treatment	0.13	1	0.13	0.002
Error		28	62.40	

Hypotheses XXII, XXIII, and XXIV

XXII. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups as measured by the mean scores of the Pre-TOUS.

XXIII. There is no significant difference (.05 level) between students whose fathers had college and students whose fathers had no college as measured by the mean scores of the Pre-TOUS.

XXIV. There is no significant interaction (.05 level) between the student's father's educational background and treatment as measured by the mean scores of the Pre-TOUS.

Table IX reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 0.009 and 3.09 neither of which were significant at the level of confidence set for this study. There was no significant interaction between father's educational background and treatment. The hypotheses XXII, XXIII, and XXIV were sustained. This indicated that male and female students dichotomized according to whether their fathers had some college or no college experience, earned mean scores, in understanding about the scientific enterprise, about scientists, and about the methods and aims of science, that were not significant.

Hypotheses XXV, XXVI, and XXVII

XXV. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups as measured by the mean scores on the Post-TOUS.

XXVI. There is no significant difference (.05 level) between students whose fathers had college and students whose fathers had no college as measured by the mean scores of the Post-TOUS.

XXVII. There is no significant interaction (.05 level) between the student's father's educational background and treatment as measured by the mean scores of the Post-TOUS.

TABLE IX

ANALYSIS OF VARIANCE OF THE TOTAL PRE-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND FATHER'S EDUCATION

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	1920.88	31	59.50	
Treatment	0.50	1	0.50	0.009
Father's Education	171.13	1	171.13	3.09
Father's Education - X Treatment	32.00	1	32.00	0.58
Error		28	55.40	

Table X presents the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 0.20 and 4.53. There was no significant difference for treatment but there was a slight significant difference for students with fathers who had some college. There was no significant interaction between father's educational background and treatment. The hypothesis XXV was sustained for treatment. This indicated that male and female students dichotomized according to whether their fathers had some college or no college experience earned means scores, in understanding about the scientific enterprise, about scientists, and about the methods and aims of science, during the semester that were not significant. The hypothesis XXVI was rejected.

TABLE X

ANALYSIS OF VARIANCE OF THE TOTAL POST-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND FATHER'S EDUCATION

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	1245.21	31	29.96	
Treatment	7.03	1	7.03	0.20
Father's Education	157.53	1	157.53	4.53*
Father's Education - X Treatment	2.53	1	2.53	0.07
Error		28	34.78	

Hypotheses XXVIII, XXIX, and XXX

XXVIII. There is no significant difference (.05 level) in achievement between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the Post-Nelson Biology Test.

XXIX. There is no significant difference (.05 level) in achievement between student's science background as measured by the mean scores of the Post-Nelson Biology Test.

XXX. There is no significant interaction (.05 level) between student's science background and treatment as measured by the Post-Nelson Biology Test.

Table XI reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 3.10 and 0.96 neither of which were significant at the level of confidence set for this study. There was no significant interaction between student's science background and treatment. These data seem to indicate that students who had a traditional science course background in High School achieve in Biological Science 1114, as well as, those students who have had at least one "new" science course in High School. The hypotheses XXVIII, XXIX, and XXX were sustained.

TABLE XI

ANALYSIS OF VARIANCE OF THE POST-NELSON BIOLOGY TEST MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND STUDENT'S SCIENCE HIGH SCHOOL BACKGROUND

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	3174.97	43	117.31	
Treatment	222.75	1	222.75	3.10
Science	68.75	1	68.75	0.96
Science X Treatment	5.11	1	5.11	0.07
Error		40	71.96	

Hypotheses XXXI, XXXII, and XXXIII

XXXI. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the Pre-TOUS.

XXXII. There is no significant difference (.05 level) between student's science background as measured by the mean scores of the Pre-TOUS.

XXXIII. There is no significant interaction (.05 level) between student's science background and treatment as measured by the mean scores of the Pre-TOUS.

Table XII presents the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 3.91 and 1.19 neither of which were significant at the level of confidence set for this study. There was no significant interaction between student's science background and treatment. The hypotheses XXXI, XXXII, and XXXIII were sustained. This indicates that male and female students dichotomized according to whether they had a least one "new" science course in high school or they had the traditional science course background in high school was of little significance.

TABLE XII

ANALYSIS OF VARIANCE OF THE TOTAL PRE-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND STUDENT'S SCIENCE HIGH SCHOOL BACKGROUND

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	3537.90	43	129.85	
Treatment	305.82	1	305.82	3.91
Science	93.09	1	93.09	1.19
Science X Treatment	11.00	1	11.00	0.14
Error		40	78.20	

Hypotheses XXXIV, XXXV, and XXXVI

XXXIV. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups, as measured by the mean scores of the Post-TOUS.

XXXV. There is no significant difference (.05 level) between student's science background as measured by the mean scores of the Post-TOUS.

XXXVI. There is no significant interaction (.05 level) between student's science background and treatment as measured by the mean scores of the Post-TOUS.

Table XIII reveals the two factorial analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 2.70 and 0.37 neither of which were significant at the level of confidence set for this study. There was no significant interaction between student's science background and treatment. The hypotheses XXXIV, XXXV, and XXXVI were sustained. This indicates that male and female students dichotomized according to whether they had at least one "new" science course in high school or if they had the traditional science course background in high school was of little significance as measured by the total Post-TOUS.

Hypotheses XXXVII, XXXVIII, and XXXIX

XXXVII. There is no significant difference (.05 level) in achievement between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the Post-Nelson Biology Test.

XXXVIII. There is no significant difference (.05 level) in achievement between students having composite ACT scores of 20 or less, 21 to 25, and 26 and above as measured by the mean scores on the Post-Nelson Biology Test.

XXXIX. There is no significant interaction (.05 level) between the student's composite ACT score and treatment as measured by the Post-Nelson Biology Test.

TABLE XIII

ANALYSIF OF VARIANCE OF THE TOTAL POST-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND STUDENT'S SCIENCE HIGH SCHOOL BACKGROUND

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2104.90	43	69.09	
Treatment	17.82	1	131.27	2.70
Science	17.81	1	17.81	0.37
Science X Treatment	13.09	1	13.09	0.28
Error		40	48.57	

Table XIV reveals the analysis of variance of male and female students participating in conventional and independent study treatments yields _F_ values of 6.23 for treatment and 9.58 for ACT Scores both of which are significant at the level of confidence set for this study. There was no significant interaction between student's ACT scores and treatment. Hypotheses XXXVII and XXXVIII were rejected. The analysis of variance test does not indicate where the ACT score means were significant, therefore, a Duncans Multiple Range Test was employed to test for differences between mean scores on the Post-Nelson Biology Test.

The Duncans Multiple Range indicated that the tabulated value of 4.13 was necessary for significance. The composite ACT score group of

20 or less and 26 or more were significantly different since their shortest significant ranges were computed as 8.00 and 10.21.

TABLE XIV

ANALYSIS OF VARIANCE OF THE POST-NELSON BIOLOGY TEST MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND STUDENT'S ACT COMPOSITE SCORES

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2886.50	41	24.94	
Treatment	262.50	1	262.50	6.23*
ACT	808.43	2	404.21	9.58*
ACT & Treatment	86.71	2	43.36	1.03
Error		36	42.17	

The Nelson Biology Test indicated the male students with mean scores of 41.00 were significantly better achievers than the female students with mean scores of 36.00.

Hypotheses XXXX, XXXXI, and XXXXII

XXXX. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups, as measured by the total Pre-TOUS.

XXXXI. There is no significant difference (.05 level) between students having composite ACT scores of 20 or less, 21 to 25, and 26 or above as measured by the mean scores on the total Pre-TOUS.

XXXXII. There is no significant interaction (.05 level) between the student's composite ACT score and treatment as measured by the mean scores on the total Pre-TOUS.

Table XV reveals the analysis of variance of male and female students participating in conventional and independent study treatment yields F values of 5.14 and 23.48 both of which were significant at the level of confidence set for this study. Hypotheses XXXX and XXXXI were rejected. The analysis of variance test does not indicate where the ACT score means were significant, therefore a Duncans Multiple Range Test was employed to test for differences between means on the total Pre-TOUS.

TABLE XV

ANALYSIS OF VARIANCE OF THE TOTAL PRE-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND STUDENT'S ACT COMPOSITE SCORES

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2986.57	41	27.73	
Treatment	160.10	1	160.10	5.14*
ACT	1461.57	2	730.79	23.48*
ACT & Treatment	88.62	2	44.31	1.42
Error		36	31.13	

The Duncans Multiple Range indicated that the tabulated value of 4.13 was necessary for significance. The composite ACT score group of 20 or less and 26 or more were significantly different since their shortest significant ranges were computed at 10.65 and 13.78.

The total Pre-TOUS disclosed a significant difference (.05 level) since the control group mean scores were 43.24 as compared to the independent study students with mean scores of 39.33.

Hypotheses XXXXIII, XXXXIV, and XXXXV

XXXXIII. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the total Post-TOUS.

XXXXIV. There is no significant difference (.05 level) between treatments, where the treatments are control and experimental groups, as measured by the mean scores on the total Post-TOUS.

XXXXIV. There is no significant difference (.05 level) between students having composite ACT scores of 20 or less, 21 to 25, and 26 or above, as measured by the mean scores on the total Post-TOUS.

XXXXV. There is no significant interaction (.05 level) between students composite ACT score and treatment as measured by the mean scores on the total Post-TOUS.

Table XVI reveals the analysis of variance of male and female students participating in conventional and independent study treatments yields F values of 0.44 for treatment and 14.45 for ACT score. There was no significant difference in interaction or treatment. There were significant differences in ACT score for the three student groups. Hypothesis XXXXIV was rejected.

Duncans Multiple Range Test was employed to determine the differences between mean scores on the total Post-TOUS.

The Duncans Multiple Range indicated that the tabulated value of 4.13 was necessary for significance. The composite ACT score group of 20 or less and 26 or more was significantly different since their shortest significant ranges were computed as 7.93 and 10.43.

TABLE XVI

ANALYSIS OF VARIANCE OF THE TOTAL POST-TOUS MEAN SCORES OF THE CONTROL AND INDEPENDENT STUDY STUDENT GROUPS TESTING TREATMENT AND STUDENT'S ACT COMPOSITE SCORES

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2040.11	41	27.30	
Treatment	12.60	1	12.60	0.44
ACT Score	830.05	2	415.02	14.45*
ACT Score X Treatment	20.05	2	10.02	0.35
Error		36	28.72	

Summary

A nested hypothesis embodying forty five specific hypotheses were researched in this study. Achievement results between two treatments, the control and the independent study students, as these treatments relate to sex, father's education, student's high school science background and composite ACT scores were compared in hypotheses I through III, XIX through XXI, XXVIII through XXX, and XXXVII through XXXX. The remaining hypotheses were examined under the same bases as above to determine the student's understanding of science as measured by the Test on Understanding Science (TOUS). A brief synthesis of these hypotheses will be presented in the summary of Chapter V.

The two factorial analysis of variance (AOV) was utilized to determine significance of mean scores between the dependent and independent variables as these scores related to the tabulated F values. The Duncans Multiple Range Test was used when appropriate to identify which means were significant when there were three or more means computed.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was an attempt to evaluate the relative effectiveness of independent study and the lecture methodology in biological science. Effectiveness of these treatments were analyzed in terms of mean score gains in achievement and understanding of science. Achievement in science was evaluated by the Post-Nelson Biology Test, Form E. Understanding of science as a process was measured by the Test on Understanding Science, Form W, on a pre and post test sequence.

The review of the literature revealed only one or two studies that focused on the use of independent study at the freshman and sophomore level in collegiate general education courses. These studies were not in the field of biological science.

A questionnaire was developed to determine the student's background and whether the student wanted to participate in the proposed independent study program at Oklahoma State University for the Spring Semester, 1970.

The samples of this study were selected from a population of approximately 500 students. Thirty-three students were randomly selected from the 378 students who proposed to follow the conventional lecture experience during the semester. There were 66 students randomly selected from the 122 students who elected independent study.

The experimental students were administered two previously described standardized instruments to measure mean score gains.

The analyses of results collected from the samples relative to understanding of science and achievement were compared by a nested hypothesis embodying forty-five specific hypotheses.

Data collected from the samples were analyzed by the analysis of variance test to determine the significant difference in mean score values as measured by the standardized instruments. The Duncans Multiple Range Test was utilized to determine exactly which means were significantly different where three or more means were found.

Hypotheses I, II, and III were concerned with determining if there was a significant difference in achievement mean scores between treatment, sex, or interaction of sex and treatment. There was no significance, therefore these hypotheses were sustained. Analyses of these data seem to indicate that male and female students do about as well in independent study as they do in the lecture experience as measured by mean scores of the Nelson Biology Test. Hypotheses IV, V, and VI were stated and sustained in the null form. These hypotheses indicate there was little mean score difference in understanding of science by male and female students as measured by the pre-TOUS as they entered the semester experience.

Hypotheses VII, VIII, and IX show there were no significant differences in student mean score gains as measured by the Post-TOUS. This suggests there is little difference as to what treatment is utilized in providing a learning situation charged with developing understanding of science for male and female students in the first semester of biological science.

Hypotheses X through XII were concerned with testing the mean score gains as measured by the pre Area I TOUS minus the post Area I TOUS. These hypotheses were sustained at the level set for this study. These data suggest male and female students attain understanding of science irregardless of treatment.

Hypotheses XIII and XV were sustained. Hypothesis XIV was rejected. These three hypotheses are concerned with whether there is a significant difference in the student's ability to perceive some of the functions of the scientist and various related areas. The female students made significantly higher gains in mean scores in the Area II Post-TOUS than did the male students.

Hypotheses XVI, XVII, and XVIII were sustained. There was no significant difference between treatments, sex, or treatment (X) sex interaction as measured by the mean scores on the Pre Area III TOUS and the mean scores on the Post Area III TOUS.

Hypotheses XIX, XX, and XXI were sustained. The analysis of variance testing the means of the Nelson Biology Test indicates there were no significant differences between the mean scores of the two treatment groups. It was found in the analyses of the student's father's educational background, in relation to how well the student performed on the standardized test, that those students whose fathers had some college were nearly significant with an F value of 4.05. The rejection point of hypothesis XX was set at 4.08.

Hypotheses XXII, XXIII, and XXIV were sustained. This indicated that male and female students dichotomized according to whether their fathers had some college or no college experience, earned mean scores in understanding about the scientific enterprise, about scientists, and about the methods and aims of science, that were not significant.

Hypothesis XXV was sustained for treatment. This indicated that male and female students dichotomized according to whether their fathers had some college or no college experience earned means scores that were not significant. Hypothesis XXVI was rejected. This indicates there is a significant difference between students whose fathers had college and students whose fathers had no college. Hypothesis XXVII was sustained.

Hypotheses XXVIII, XXIX, and XXX were sustained. These data seem to indicate that students who had a traditional science course background in High School achieved in Biological Science 1114, as well as those students who have had at least one "new" science course in High School.

Hypotheses XXXI, XXXII, and XXXIII were sustained. This indicated that male and female students dichotomized according to whether they had at least one "new" science course in high school or they had the traditional science course background in high school was of little significance.

Hypotheses XXXIV, XXXV, and XXXVI were sustained. This indicated there is no significant difference in the high school science background of the students participating in this study.

Hypotheses XXXVII and XXXVIII were rejected. The analysis of variance test of mean differences indicated there was a significant difference between achievement and understanding science and composite ACT score groups. Hypotheses XXXIX was sustained.

Hypotheses XXXX and XXXXI were rejected. The composite ACT score group of 20 or less and 26 or more were significantly different since their shortest significant ranges were computed at 10.65 and 13.78. Hypothesis XXXXII was sustained.

Hypotheses XXXXIII and XXXXV were sustained. These data indicate there was no significant difference in treatment and ACT score and treatment interaction. Hypothesis XXXXIV was rejected. There was a significant difference between students having composite ACT scores of 20 or less, 21 to 25, and 26 or above, as measured by the mean scores on the total Post-TOUS.

If an attempt was made to present an individual student profile while would be appropriate to serve as a screening device model for the selection of independent study students, the findings of this study seem to indicate these criteria.

There was no significant difference between the pre-TOUS test scores of males and females at the beginning of the experiment. The Pre minus Post-TOUS Area II mean scores were significantly different. These results indicated the females scored significantly better than the males. This seems to indicate that the female students worked harder during the semester than the males. Female students, generally speaking, might do better in independent study than male students.

The mean scores of the control and independent study student groups testing treatment and student's science background in high school were not significant at the level set for this study. These data seem to indicate that students who had a traditional science course background in high school achieve in Biological Science 1114 as well as those students who have had at least one "new" science course in high school.

Students whose fathers have had some college education compiled mean scores which were higher than the student group whose fathers had not attended college.

The composite ACT scores of the students could serve as a screening device for selecting students for independent study. The mean scores compiled by the students on the standardized instruments increased as the composite ACT scores increased. This seems to indicate that the better students achieved less on the standardized tests.

In summary, important criteria for the selection of independent study students might be considered in terms of sex, father's educational background, and composite ACT scores.

Recommendations

This study revealed that independent study is feasible for a general studies course such as biological science. It appears that extensive research is needed to put the segments of a learning situation into a functional methodology. This task should be given consideration by persons involved in curriculum development as well as by teachers at all educational levels.

The findings and conclusions of this study suggest several areas for further research:

1. The factors that promoted different achievement and levels of understanding science for the one-semester study should be investigated.

2. Require students to take all of their course work in "independent study" courses for at least a semester and preferably for one or two years.

3. Review the teaching methods employed in (and outside of) independent study, and experimenting with some one appropriate method such as using the inquiry approach.

4. Studies should be initiated to determine the long-term recall or material retention of independent study students as compared to students taught under the traditional methods.

5. This study or one like it should be carried out for a longer period of time to amplify any significant differences in achievement and understanding of science that occur between the two instructional methods.

6. Develop a resource library of effective lectures, conferences and laboratories, seminars and colloquia, prepare bibliographies of reading sources and syllabi developed in diverse subjects at different levels for use by independent study students.

7. Attitudinal studies should be conducted to determine the student's acceptance of or the rejection of independent study.

Conclusions

The findings of this study suggested the following conclusions which could be applicable to other studies involving students similar to those in this experiment.

1. The independent study experience was at least as effective as the traditional method of instruction.

2. In the cognitive areas, no significant differences in achievement existed between the two instructional methods as measured by the Nelson Biology Test.

3. Achievement and understanding of science differences that existed between the two student groups were due to inherent factors within the groups, rather than to the experimental method.

4. Students of independent study groups seemed highly satisfied with this innovative methodology.

5. Students of this study with composite ACT scores of 26 or above scored significantly better than students from the categories of 21 to 25, and 20 or less.

6. Female students of both treatments scored significantly better in relation to mean scores in the Area II Pre minus Post-TOUS than did the male students.

The students evaluated the independent study experiences at the end of the semester. Their responses were randomly selected to be presented here:

1. This course was very interesting. It gave one more time to devote to his own interest in the field of biology. . . . I hope they continue this type of program for others to take.

2. I have enjoyed this course a great deal. I feel I have gained more than from the traditional lecture course. The difference in testing with (by) being allowed to discuss and use books, then applying that knowledge to a situation was a means of learning that should be employed more often. The test became a time of learning not punishment. Perhaps a more definite set of objectives would have been helpful in studying.

3. This course adds to the true purpose of college . . . willfull independent study. Films-experiments (lab), a special speaker would have helped. Mimeographed questions, also might have helped in motivating study.

4. This independent study course has a definite value to the student because he can learn at his own rate and research enables the person to learn a great deal more than being spoon-fed. Testing lacks something because it does not always test what one learns. I would recommend this method of learning.

5. In my opinion this would be best for me and my abilities but I know a few guys that knew more than I before taking the course and did not really get anything out of the course. I felt like I learned a lot more than if I'd taken the regular course. Here again it is the attitude of the student on his own to do research on his own. In my opinion this course is for the highly knowledged student and the slow learners.

6. Good start in teaching individual to work on his own. Outlined lectures of material in the book is a waste of time for the majority of students. This gives leeway into how deep you wish to pursue one topic, and pass over another. Informal lectures and general and relative material excellent and interesting, as long as not repetition of the book. Research papers also excellent and interesting to do. Experiments should be emphasized more.

7. I like taking independent study because a student is allowed to regulate his own learning which makes it easier in some ways on the student by not having to exert himself when loaded down with other things but rather study when he is in a better studying situation. There is also a considerable closer relationship between the teacher and student. I think students can work at his own level without being pulled behind or dragged ahead.

8. I think this course can be an excellent one if the students in it can be counted on to fulfill the objectives prescribed for them. However, too many times when a student has a choice of when he has to prepare for a program such as this, he procrastinates. I think a bit more structure should be introduced in the way of goals or time-table or something. But I sure don't think it should be all lecture like it currently is under regular classes.

9. Though this course might not work for every student, I think it is the best way of presenting the course. There is no reason for having to be told things which can be read; this is a waste of time. It is true that the motivation to study here is not as great as in regular lecture, but the student who does not study here probably wouldn't for lecture either. One thing--it might be nice to have some lab work. Good luck with your program, methods of instruction haven't changed much. We need the change.

10. I really enjoyed the liberty we had in independent study to work at our own pace and do our own research. However, I didn't develop as much initiative as I had hoped to--which was all my fault. I wished for the research that instead of summarizing an article, that we could have picked a topic, which we could just write a report on. I say this because it's hard for me to understand so many of the articles in <u>Scientific American</u> and <u>Science</u>. On the whole the class was interesting and I feel I learned more than I would have in a lecture class. My grade may not show this, but I know that I'll remember more because I had to get it for myself.

One selected evaluation which seems to sum up the general opinion of the students:

11. I think that this will prove to be the most interesting and certainly the most beneficial course that I have taken this year. The experience of having done it mostly on my own has been a great influence upon my other courses of study. I feel that if I can benefit from such a course at least 50% of the people of this campus can. I would very much like to see this type of study develop further within this course and possibly in other courses. In short I have nothing but praise for this type of independent study.

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APPENDIX A

BIOLOGICAL SCIENCE 1114

STUDENT QUESTIONNAIRE

Education 6000 Research by
Ben Frye & Lloyd Stavick
January, 1970

BIOLOGICAL SCIENCE 1114 STUDENT QUESTIONNAIRE

We can assure you that all information which you give us will be kept strictly confidential. It will not be graded in any way. Statistical analysis and other manipulation will be done with your respective code number. Thank you very much for your cooperation.

Student's name ______________
Code number ______________
Classification: Fresh __ Soph __
Junior __ Senior __

School Address ______________
" Phone __________
Home Address ______________
____

Sex: Male ____ Female ____
Age ________
Status: Married ___ Single ___
ACT Score (Composite) ________
Major Field ______________
Father's Occupation __________
Father's Highest Educational Attainment ______________
Mother's Highest Educational Attainment

Science Background (please check those you have taken)

College

____Zoology
____Botany
____General Chemistry
____Organic Chemistry
____Physics
____Other

High School

Biology (BSCS Versions)
Blue _____ Green _____ Yellow _____
Special Materials _____

Biology (Traditional or Regular)____
Physics PSSC _____ Regular _____

Chemistry-Regular ____ Chem Study___
Other

Earth Science-ESSP _____ Regular_____

I consider myself to be a fast ____, slow ____, or medium ____ speed learner.

I WOULD LIKE TO PARTICIPATE IN THE INDEPENDENT STUDY PROGRAM THIS SEMESTER __________YES.

I WOULD NOT LIKE TO PARTICIPATE IN THE INDEPENDENT STUDY PROGRAM __________NO.

APPENDIX B

INDEPENDENT STUDY STUDENT

EVALUATION CHART

INDEPENDENT STUDY STUDENT EVALUATION CHART

Unit Grades	Student	Age	Sex	Cla	Bkg Code	TOUS	Nels	Indiv Confer	Other comments
(1)									
(2-3)									
(4)									
(5)									

Additional:

VITA

Lloyd Clair Stavick

Candidate for the Degree of

Doctor of Education

Thesis: INDEPENDENT STUDY OF COLLEGIATE BIOLOGICAL SCIENCE AS A GENERAL EDUCATION COURSE: INVOLVING ACHIEVEMENT AND UNDERSTANDING THE PROCESSES OF SCIENCE

Major Field: Higher Education

Biographical:

Personal Data: Born at Sisseton, South Dakota, October 19, 1935, the son of Clarence and Frances Stavick.

Education: Received the Bachelor of Science Degree from General Beadle State Teachers College, Madison, South Dakota, with a major in Physical Education in July, 1961; received the Master of Science degree from Oklahoma State University, Stillwater, Oklahoma, in May, 1968, with a major in natural science; pursued graduate work in science and education at Oklahoma State University, Stillwater, Oklahoma, South Dakota State University, Brookings, South Dakota, and Colorado State College, Greeley, Colorado; and completed the requirements for the Doctor of education Degree at Oklahoma State University, in May, 1971.

Professional Experiences: Served as a radioman in the Army Security Agency of the United States Army from 1955 to 1958; as a radioman in the United States Naval Reserve from 1963 to 1967; as a teacher of biology and physical education at Astoria High School, Astoria, South Dakota, 1961-1965; as a teacher of biology at Sturgis High School, Sturgis, South Dakota, 1965-67; as a teacher of biological science at Upton High School, Upton, Wyoming, 1968-69; as a participant in a National Science Foundation Summer Institute at Colorado State College, Greeley, Colorado, 1966; as a participant in a National Science Foundation Academic Year Institute at Oklahoma State University, Stillwater, Oklahoma, 1967-68; and as a teaching assistant in biological science at Oklahoma State University from 1969-70; as a teacher of biological science at Watertown High School, Watertown, South Dakota, 1970-71.

Professional Organizations: Member of the South Dakota Education Association; National Education Association; South Dakota Biology Teachers Association; and the Wyoming Mathematics and Science Teachers Association.