AUDIO-TUTORIAL BIOLOGY IN LYMAN BRIGGS COLLEGE AT MICHIGAN STATE UNIVERSITY

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ABSTRACT

AUDIO-TUTORIAL BIOLOGY IN LYMAN BRIGGS
COLLEGE AT MICHIGAN STATE UNIVERSITY

By

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Problem investigated. The purpose of the study was to examine an experimental, introductory biology course in Lyman Briggs College at Michigan State University. This course was implemented as a variable content-variable credit program by means of an audio-tutorial approach. The study was designed to include an appraisal of student achievement in the course, an evaluation of student participation in the program, and an assessment of student reaction to the instructional environment provided.

Descriptive features and treatment of data. The students enrolled in Lyman Briggs College Biology 140 during winter term, 1969, provided the population for the study. The population was surveyed with a pre-course Student Preparation and Intent Questionnaire to collect relevant biographical information and a post-course Course Evaluation Questionnaire to collect student reactions to the course.

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A Course Achievement Test was administered at the beginning and at the end of the course. One hundred thirty-seven students were categorized by biology preparation in high school, content sequence chosen for the college course, and sex and the test data analyzed for significance with the one-way analysis of variance and t test techniques. Correlation coefficients between posttest scores and time spent in individual study sessions on specific course content were also obtained and the z statistic used to check for significance of the values.

Findings. The following conclusions were supported by the data:

1. The kind of biology course the students had in high school was not a significant contributor to pretest achievement scores on a test designed for the college course.

2. The number of biology courses the students had in high school was not a significant contributor to pretest achievement scores on a test designed for the college course.

3. Students who selected more content in the college biology course tended to show higher posttest achievement scores on a test designed for the course than those who selected less content.

4. Male and female posttest achievement scores on a test designed for the college biology course were not significantly different.

5. Positive correlation coefficients between time spent in individual study sessions and posttest were found in four course content areas, but only one of these coefficients was sufficiently large for the finding to be significant.

From findings derived from questionnaire responses relating student reactions to the course program, the following major conclusions were made:

1. More students at the beginning of the course liked the idea of an audio-tutorial course than actually liked taking an audio-tutorial course.

2. The students generally believed the course contributed to their awareness of and interest in ecological relationships and to an understanding of the areas of biology studied.

3. The students generally found the prepared study guide materials to effectively organize the content materials and experiences presented although they tended to avoid the experiences presented outside the study carrel.

The study, conducted as an integral and ongoing facet of curriculum development in Lyman Briggs College at Michigan State University, indicates that continued improvements in college biology curricular programs are possible, but that the development of innovative programs is a long term task. Additional research is needed to clarify the relationships between academic ability, intellectual attitudes, varying amounts of classroom direction, and academic achievement in audio-tutorial programs.

AUDIO-TUTORIAL BIOLOGY IN LYMAN BRIGGS COLLEGE AT MICHIGAN STATE UNIVERSITY

By

Paul Dale Hoeksema

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CHAPTER I

INTRODUCTION

Curriculum reform in biological science education, comparable to the recent decade of reform in the high school science curriculum, should be directed toward upgrading instruction in college biology with effective and efficient core curriculum programs. Although there are no final answers to questions concerning curricular programs, designs should follow the growth and expansion of scientific knowledge and understanding and improvements in educational technology.

The task of determining the need for change and the necessary action to bring about the changes are so complex that many institutions are hesitant to attack these problems.[1] For example, the point of view is held by some individuals that if something cannot be proven wrong with what is presently in operation, then the effort necessary for the systematic and continuing attention toward improvement is

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[1]Richard G. Telfer. "Dynamics of change forces behind curriculum modification." The Clearing House 41:134; November 1966.

unnecessary.[2] Planning for curriculum change should include a thorough exploration of the possibilities of new teaching aids and methods. The curriculum changes should include the best of current educational technology and may be expected to involve a more widespread and ingenious use of independent study.[3]

Novak infers that curriculum changes are often talked about, explored, and planned, but seem to falter when attempts are made to introduce these changes into the classroom.[4] The implementation problem related to curricular change at the college level is one of the more crucial problems that exists in higher education today.[5] Besides the task of producing the materials and techniques necessary for implementing new programs, patience and persistence are required for putting changes into practice.[6]

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[2]William Newsom. "Curriculum building practices on the college level." Peabody Journal of Education 35:160; November 1957.

[3]John W. Gardner. "Agenda for the colleges and universities." The Journal of Higher Education 36:360; October 1965.

[4]Alfred Novak. "The model biology curriculum." Bioscience 16:519; August 1966.

[5]Fred Guggenheim. "Curricular development through research." Education 84:49; September 1963.

[6]W. W. Charters. "Is there a field of educational engineering?" Educational Research Bulletin 24:30; February 14, 1945.

The 1956 National Academy of Science Conference "urged widespread continuing and concerted effort by biologists to re-examine college biology programs and seek ways to improve them".[7] The President's Science Advisory Committee in its report Education for the Age of Science, issued in May, 1959, stressed the need for a specific and urgent attention throughout educational systems for improvement programs to bring about a major reconstruction and modernization of curricular programs and course content.[8] The demand for innovatively directed quality programs has not been merely vocal. The National Science Foundation has supported the development of individual science curriculum projects at the elementary, junior high, and high school levels and the work carried on by the Commission on Undergraduate Education in the Biological Sciences. This commission, founded in October, 1963, grew out of a recommendation of the Education Committee of the American Institute of Biological Sciences and their concern for the need of a continual evaluation of undergraduate instruction in the biological sciences.[9]

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[7]National Academy of Science. Conference on Undergraduate Curricula in the Biological Sciences. Washington, D. C.: National Academy of Science. Publication # 578, 1958. p. 83.

[8]National Science Foundation. "The role of the National Science Foundation in course content improvement in secondary schools." The School Review 70:1-2; Spring 1962.

[9]Thomas S. Hall. "New directions in biology teaching." Bioscience 14:31; April 1964.

There has usually been a concern about the quality of teaching, but:

> . . . there has been a suspicion of anything that savored of concern about 'methods' and the feeling has been widespread that with highly motivated students any professor well grounded in his discipline can provide good instruction without subjecting his classroom practices to objective scrutiny.[10]

The curricular reform movements have brought with them a concern for educational method.[11]

> . . . curriculum reforms are generally ineffective, make little headway and lack traction until they are 'materialized' into instructional materials, learning environments, and systems of instruction.[12]

The development and emergence of new biology course content, new techniques of instruction, and the availability of new media and materials have occurred at all school levels. Students coming out of some high school courses are bringing concepts and skills that may require a modification of what is taught and how it is taught at the college level.[13,14]

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[10]Paul L. Dressel. "The planning of instruction." Improving College and University Teaching 14:69; Spring 1966.

[11]Theodore R. Sizer. "Classroom revolution: reform movement or panacea?" In: Controversy in American Education. Harold Full (ed.). New York: Macmillan Co., 1967. p. 68.

[12]Phil C. Lange. "Technology, learning, and instruction." Audiovisual Instruction 13:228; March 1968.

[13]Russell M. Cooper. "The need for educational change." Educational Record 48:252; Summer 1967.

[14]C. Easton Rothwell. "From high school to college: new problems in adaptation in the high school curriculum." Journal of Secondary Education 37:233; April 1962.

The fact that some high school students have had excellent preparatory programs in biology is evidenced by the results of a questionnaire survey of two hundred biology departments, in all types of colleges and universities, which illustrated that ". . . students who have had the BSCS Second Course[15] . . . seem to be about equal to those who have completed a half year of a freshman collegiate biology course".[16] Entering college freshmen students also represent a conspicuous upward shift in median ability levels.[17]

New departures are called for and are possible in the college biology curriculum.[18] The total educational climate of the college and the intellectual needs of the students should be such that any proposed changes can become a functional part of the college curriculum.[19]

> Curriculum redesign must be imaginative, it must have strong administrative support, and foremost, it must have a faculty who wants a new curriculum, has time to design

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[15]Biological Sciences Curriculum Study. Biological Science: Interaction of Experiments and Ideas. Englewood Cliffs, N. J.: Prentice-Hall; 1965.

[16]Biological Sciences Curriculum Study. About BSCS Biology. Boulder, Colorado: American Institute of Biological Science-Biological Sciences Curriculum Study, August 1967. p. 10.

[17]Arvo E. Juola. "Ten-year trend in ability scores of M.S.U. entering freshmen." In: "EDP comment." No. 3. East Lansing: Michigan State University, Fall 1968.

[18]Donald G. Humphrey. "A new day in biology teaching." Improving College and University Teaching 13:75; Spring 1965.

[19]Novak, loc. cit.

> one, is personally involved in the designing, and has the urge to teach it as designed.[20]

Need for the Study. Lyman Briggs College, one of three residential colleges at Michigan State University, is designed to provide students with a liberal education. The college curriculum emphasizes the biological and physical sciences and mathematics. The College began accepting freshman students in the fall of 1967. A new class is added each year and the necessary courses are provided or developed as required. University guidelines established for the College Planning Committee directed the college "to innovate and to 'learn by doing' in the areas of curriculum, teaching, and administration".[21] The guidelines also noted that a major responsibility of the college faculty would be:

> . . . the development of new materials and means for facilitating student learning as well as the incorporation in their teaching of the best existing materials and means to achieve this goal.[22]

The Lyman Briggs College Planning Committee has provided opportunity for the College to ". . . provide a laboratory for comparatively small scale experimentation and innovation in undergraduate instruction".[23] Initial efforts

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[20] Ibid.

[21] Lyman Briggs College Planning Committee. "Summary of and responses to Byerrum committee quidelines for college II." East Lansing: Lyman Briggs College, Michigan State University, n.d. p. 3. (Mimeographed.)

[22] Ibid.

[23] Lyman Briggs College Planning Committee. "Proposed curriculum for Lyman Briggs College." Report to the Michigan

included the design of a structured sequence of experiences to develop the facility and the desire for independent study in students.[24] Lyman Briggs College Biology 140, The Organism and Its Environment, is the first such experimental course offering a variable content-variable credit program using an audio-tutorial approach.

The development of an innovative biology program for a new college is a long term task. The task of approaching curricular development is a multi-dimensional one since all facets of the teaching-learning situation are necessarily involved.[25] The continued development of an effective curriculum involving content and method changes and improvements should never end.[26] All modifications made should result in an improvement of a course or curriculum; they should not be made just for the sake of change. The evaluation of a developing program should be continuous in the sense that the processes involved should precede decisions related to changes in the program. Feedback evidence of student learning should be considered in making program modifications. Student participation and achievement in a

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State University Curriculum Committee. East Lansing: Lyman Briggs College, Michigan State University, n.d. p. 13.

[24]Ibid.

[25]Fletcher G. Watson. "Curriculum design in science." The Science Teacher 30:13; March 1963.

[26]W. Hugh Strickler. "A superior college course." Improving College and University Teaching 15:128; Spring 1967.

course and student reaction to curricular developments may be essential to the decision making process. In view of the curricular developments occurring at Lyman Briggs College in biology, this study was deemed necessary to obtain relevant data relating to student achievement in the course together with student reaction to the operational features of the course.

Purpose of the study. The main purpose of this study was to examine an introductory, audio-tutorial biology course in Lyman Briggs College at Michigan State University. Basic to this primary purpose was an appraisal of student achievement in the course, an evaluation of student participation in the program, and an assessment of student reaction toward the instructional environment provided.

General design of the study. The study was conducted as an integral and ongoing facet of curriculum development in Lyman Briggs College at Michigan State University. The study was conducted during the winter term, 1969. An account of the development of the biology course investigated covers the period from the summer term, 1967, to the winter term, 1969. The evaluative aspects of the study began at the opening of the winter term on January 6, 1969, and closed with the end of the term on March 12, 1969.

A Student Preparation and Intent Questionnaire (Appendix A) was used to obtain biographical data related to high school preparation in biology and initial student reaction to an audio-tutorial course approach. A Course Achievement Test (Appendix B) was prepared and used as a pretest and posttest for the course to obtain a measure of student achievement. Student opinions related to the presentation of the program and individual participation in the course were surveyed with a Course Evaluation Questionnaire (Appendix C).

Students in the study. The students enrolled in Lyman Briggs College Biology 140, at Michigan State University, during the winter term, 1969, constituted the population considered in the study. There were one hundred forty-five students enrolled in the course. One hundred thirty-seven students completed the instruments involved in the study as a requirement for inclusion in the statistical aspects of the study. There were ninety-seven males and forty females involved. One hundred thirty of these students were freshmen and seven were sophomores. Student reactions to the course program were accepted from all students enrolled in the program.

Hypotheses of the study. This study was designed in part to measure the relationship of high school preparation in biology, the specific student elected content sequence completed, sex, and time spent in individual study sessions to achievement in an introductory college biology course. A brief description of the development of the course and the resulting organizational structure of the course are presented in Chapter III.

The determination of achievement for students in the course was based on posttest scores students received for the content packages presented during the course. Five research hypotheses related to student achievement in the course proposed by the investigator were as follows:

1. Students who have had BSCS Biology in high school have higher pretest scores on a test designed for a college biology course than students who have not had a BSCS Biology course in high school.

2. Students who have had more high school preparation in biology have higher pretest scores on a test designed for a college biology course than students who have had less high school preparation in biology.

3. Students who select more content in a variable content-variable credit college biology course have higher posttest scores on a test for the college course than those students who select less content.

4. Male students receive higher posttest scores on a test designed for a college biology course than female students receive on the posttest.

5. Students who spend more time in individual study sessions on the content materials presented in a college biology course receive higher posttest scores on tests for the college course than students who spend less time in individual study sessions.

Definition of terms. For the purpose of this study, the following terms are defined as they were used in the investigation.

1. Independent study was:

> . . . an approach to learning . . . that embraces various teaching and learning procedures in which the student assumes a major responsibility for his education and shows significant independence in

some or all aspects of the learning process, whether apart from or in organized courses.[27]

2. Self-directed study was an instructional approach in which course structure is preserved with a single instructor simultaneously guiding the work of many students.[28]

3. Audio-tutorial approach was an educational program integrating all teaching and learning experiences. A taped program and two-by-two slide sequence presented in individual study carrels were used to guide students through a series of planned activities in the carrel and in the laboratory. Students proceeded through the program at their own rate. Their pace was determined in part by their prior experiences. Additional weekly sessions were scheduled to supplement the materials presented by means of the taped program and to check individual progress.

4. Content package was a subject matter program providing student access to specific content areas in which guidance was given for planned learning activities.

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[27]Winslow R. Hatch and Alice L. Richards (eds.). Approach to Independent Study. New Dimensions in Higher Education Series #13. Washington, D.C.: Office of Education, 1965.

[28]Howard E. Gruber and Morris Weitman. "The growth of self-reliance." School and Society 91:222; May 4, 1963.

5. Variable content-variable credit course was a course in which the student was allowed some freedom to elect the content he wished to complete. The amount of extra credit received was relative to the amount of content selected beyond a required course minimum and the achievement shown.
6. Content sequence was the specific set of content packages students elected to complete in a variable content-variable credit course.
7. Large assembly session was one of three sessions in an audio-tutorial course format at which a senior staff member directed activities suitable for large group involvement. These activities included films, minilectures, guest speakers, testing, and discussion.
8. Individual study session was a session which allowed a student in a nonscheduled, individualized learning situation, provided in a laboratory study carrel, to work with content package materials.
9. Recitation and response session was a scheduled session which gave students, in small groups, the opportunity to respond to and discuss aspects of previously studied content materials.
10. Advanced placement was an advanced standing in college work with or without credit on the basis of college level work during high school.

Assumptions of the study. In designing the study, the following assumptions were made:

1. The pretest given prior to student participation in the activities of the course had no significant learning value.
2. The questionnaires presented were valid instruments for the collection of data relative to the students and the data.
3. The pretest and posttest were valid instruments for the content presented in the course and were adequate samples for the specific content packages.
4. Any learning within the areas posttested which did not constitute a part of a student's elected content sequence resulted from his study in the other areas.
5. Any data lost because of an incomplete return of the opinion questionnaires was random and the remaining samples were representative of the total population.

Organization of the dissertation. This chapter contains the need, purposes, general design, student population, hypotheses, term definitions, and assumptions of the study. A description of common "core" biology programs is presented in Chapter II as well as a review of literature related to independent study, self-directed study, and audio-tutorial programs. Pertinent information related to advanced placement is also reported in Chapter II. Chapter III contains a brief description of Lyman Briggs College and the implementation and evolved organizational features of the introductory, audio-tutorial biology course. The sources of data and the treatment of these data are described in Chapter IV. The findings related to the data collected are presented in Chapter V. Chapter VI contains the conclusions of the study and some educational implications.

CHAPTER II

REVIEW OF LITERATURE

A review of literature pertaining to core curricula in college biology, independent study, and self-directed study programs is presented in this chapter. Information relative to the audio-tutorial approach to learning and advanced placement programs is also reported.

Core curricula in college biology. A review of the literature relative to core curricula in college biology reveals that a "core curriculum in biology" has different connotations at different educational institutions. The concept of a "core curriculum", which would include that body of knowledge essential for all students of college biology, also has different meanings for different people. The determination of the objectives of and content for a "core" biology course involves the treatment of the nature of biological science, the nature of the students to be taught, the nature of the learning process, and the nature of societal conditions of the time. The factors involved in arriving at acceptable objectives and course content are complex and, at present, no general agreement has been reached. One of the basic problems is illustrated in the following comment made at the CUEBS[1] Stanford Colloquium on Biology in a Liberal Education:

> Whatever problems contemporary biological education faces, they are primarily the result of the success and expansion of the field as an academic discipline. New methods, new information, and new problems, all have eroded away the central elements which characterize the earlier systems of thought and our teaching of biology must mirror these changes.[2]

In the deliberations held at the Stanford Colloquium, several proposals were submitted for the organization of a liberal arts, introductory biology course. The proposals included: (1) the "inquiry" approach, (2) the "scientific method" theme, (3) the "evolution" approach, (4) the "whole organism" theme, (5) the "organismal-environment" complex, (6) the "themeless" course, and (7) the "paperback" course.[3] For some participants, the selection of content based on a theme was most important, while for others the method of presentation was more important.[4]

In a report of the CUEBS Panel on Undergraduate Major Curricula,[5] completed after an examination of representative

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[1]CUEBS is used to designate the Commission on Undergraduate Education in the Biological Sciences.

[2]Jeffrey J. W. Baker (ed.). Biology in a Liberal Education. Report of the Colloquium on Biology in a Liberal Education, Stanford University, August 2-13, 1965. CUEBS Publication # 15. Washington, D.C.: CUEBS, February 1967. p. 7.

[3]*Ibid*., pp. 15-20. [4]*Ibid*., p. 15.

[5]Commission on Undergraduate Education in the Biological Sciences. Content of Core Curricula in Biology. Report of the Panel on Undergraduate Major Curricula, CUEBS Publication # 18. Washington, D.C.: CUEBS, June 1967.

core biology programs in biology at Purdue, Stanford, North Carolina State, and Dartmouth,[6] some important trends in biological science education were identified:[7]

1. There is a curricular core of biological knowledge to be transmitted to all biologists, regardless of their intended specialization.

2. More adequate preparation of students in mathematics, physics, and chemistry allows undergraduate biology to be taught at a more sophisticated level.

3. Molecular, cellular, and population levels of biological organization are being increasingly emphasized over morphology and systematics.

4. Heredity, the cell, development, mechanisms of integration, and evolutionary dynamics have replaced the phylogenetic approach as organizing principles.

5. Curricular changes are usually solutions to particular problems. There are no curriculum revision shortcuts and no single ideal curriculum.

6. The basic criterion for sound curriculum decision-making is content significance, not recency.

Biology courses in the core curricula for biology majors at the four institutions are given in Table I. The titles of these courses suggest a diverse organization of information in the various programs. However, this conclusion is somewhat misleading.[8] Each of these core programs contained approximately two thousand individual items of information.

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[6]Representative sample included a large private school (Stanford), two state institutions (Purdue and North Carolina State), and a small, private, liberal arts institution (Dartmouth).

[7]CUEBS, op. cit., pp. 27-28.

[8]Ibid., p. 15.

Table I. Biology courses in core curricula for biology majors at selected institutions[a]

		Purdue University	North Carolina State University		Stanford University	Dartmouth College
Freshman	1 Sem	Principles of Biology	General Biology	1 Qtr		
	2 Sem	Principles of Biology		2 Qtr		
				3 Qtr		
Sophomore	1 Sem	Structural Biology	General Morphology	1 Qtr	Fundamentals of Biology	Life Science (optional 1st or 2nd yr.)
	2 Sem	Environmental Biology	Animal Life	2 Qtr	Plants as Organisms	Life Science (optional 1st or 2nd yr.)
				3 Qtr	Animals as Organisms	
Junior	1 Sem	Cell Biology	General Microbiology	1 Qtr	Molecular Biology	Cell Physiology
	2 Sem	Developmental Biology	Plant Physiology or Animal Physiology	2 Qtr	Cell Physiology	Required electives: one in Animal Science and one in Plant Science
				3 Qtr	Population Biology	
Senior	1 Sem	Genetic Biology	Genetics	1 Qtr		
	2 Sem			2 Qtr		
				3 Qtr		

[a]Adapted from CUEBS. Content of Core Curricula in Biology. Report of the Panel on Undergraduate Major Curricula, CUEBS Publication # 18. Washington, D.C.: CUEBS, June 1967.

Some two hundred fifty lecture hours or equivalents were allocated by each institution to these items. Seven per cent of the items appear in the programs of all selected schools. These items comprise sixteen per cent of the total core time. Five hundred items and fifty per cent of the core time appear in the programs of three of the four institutions.[9] The Panel and Commission recommended that:[10]

1. An in-depth analysis be used in the examination and redesign of curricula that have not recently been analyzed.

2. Curriculum analysis and redesign require the individuality of the teacher and his department while insuring that students will be well prepared for further professional advancement.

3. Biology courses should be related to the background that students have in mathematics, physics, and chemistry.

4. A common or core program in biology cover a minimum of two years of courses to be taken in a fixed sequence.

5. A balanced curriculum cover the now recognized fundamental concepts so that students are made sufficiently aware of the scope of biology.

CUEBS[11] reported that seventeen representative institutions were making progress with respect to accomplishing meaningful curriculum changes. The report noted that some

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[9] Ibid., p. 21.

[10] Ibid., pp. 30-33.

[11] CUEBS. "The ever changing curriculum." CUEBS News 5(3); February 1969.

of the curricular changes were accomplished by means of innovative features. The results of these planned programs for curriculum change supports the point of view that curricular innovation and experimentation are closely allied with high morale and productivity.[12] The CUEBS report also supports the generalization ". . . that once a faculty commits itself to a serious examination of its teaching responsibilities, it continually revises its curriculum".[13] The inference can be drawn from CUEBS publications that introductory biology courses are needed at the college level and that there is no one best course. Thus, the conclusion appears valid that several courses should be developed for trial and feedback in a continuous curriculum revision program.

Another problem in curriculum development is illustrated by the report of the Committee on Educational Policies of the Biology Council. The report of this committee noted that colleges and universities are custodians of learning, but more importantly are also producers of learning.[14]

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[12]William Alexander. "Innovations in curriculum development." Virginia Journal of Education 61:22; September 1967.

[13]CUEBS, Content of Core Curricula in Biology, op. cit., p. 7.

[14]Committee on Educational Policies of the Biology Council. Improving College Biology Teaching. NAS-NRC Publication # 505. Washington, D.C.: National Academy of Sciences - National Research Council, 1957. p. 3.

Thus, in curriculum development, there is a need for this idea to be reflected in a continuing renewal of courses and curricula. The committee called for a continuing effort "to break the academic lockstep" and "unleash the learning capacities of students".[15] The committee also contended that biology teaching might be most vital and stimulating if creative and experimental teaching attitudes existed.[16]

Independent study -- Self-directed study programs. Since the purposes of independent study and self-directed study programs are somewhat similar they are reviewed together in this report. Bonthuis, Davis, and Drushal,[17] in an account of the operation of independent study programs in the United States, noted that a purpose of higher education is to stimulate and assist individual growth. They reported that independent study has been used as a way to help students enrich and accelerate programs, although it was usually held to be the prerogative only of superior students.[18] They defined independent study as a program:

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[15]Ibid. Also see Fred T. Wilhelms. "The curriculum and individual differences." In: National Society for the Study of Education. Individualizing Instruction. Chapter IV, Sixty-first Yearbook, Part I. Chicago: University of Chicago Press, 1967. p. 64.

[16]Committee on Educational Policies of the Biology Council, op. cit., p. 42.

[17]Robert H. Bonthuis, F. James Davis, and J. Garber Drushal. Independent Study in the United States. New York: Columbia University Press, 1957. p. vii.

[18]Ibid.

> . . . which provides a formal opportunity on an institution wide basis for the pursuit of special topics or projects by individual students, under the guidance of faculty advisors, apart from organized courses, for honors only or for credit toward graduation, available to students who meet certain requirements or required of all students.[19]

One of the first attempts to provide an independent study program was the introduction of a course elective system at Harvard University in 1869.[20] The elective system did not alter teaching, but did allow more student freedom in determining the content of an educational program. In 1909, this student controlled curriculum at Harvard was replaced with a concentration-distribution system which allowed students to elect subjects in various areas, but required courses to be taken in a number of fields.[21] In 1912, the comprehensive examination was added at Harvard as a stimulus to broad learning and an achievement measure in the new curriculum and a tutorial system was introduced to insure maximum effectiveness in these examinations.[22]

One reason for the application of individualized education programs to undergraduate students has been the success experienced by university teachers using these methods with graduate students.[23] Between 1920 and 1930 more than seventy-five institutions adopted some kind of

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[19] Ibid., p. 9.

[20] Ibid., p. 11.

[21] Ibid.

[22] Ibid.

[23] Ibid., p. 10.

program for individual instruction.[24] The goals of these programs were:[25]

1. To give students a better grasp of the meaning of scholarship.
2. To acquaint students with the methods and techniques of gaining new knowledge.
3. The development of an ability to analyze, organize, and present new knowledge.
4. The improvement of undergraduate academic work.
5. The enrichment of academic majors.
6. To relieve students from the restraints of course work.
7. To increase the responsibility of a student for his own education.
8. To bridge important gaps in student knowledge in a given academic area.
9. The encouragement of tutorial instruction in departments too large to make it possible.
10. The encouragement to pursue subjects of personal interest.
11. To attract superior students to college.
12. The granting of college degrees which would have increased distinction.

The most frequent change in independent study programs over the years has been an increased subject and work latitude.[26]

Van Deventer[27] listed several approaches to individualized instruction in science courses. These approaches

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[24]*Ibid.*, p. 12. [25]*Ibid.*, pp. 36-39.

[26]*Ibid.*, p. 17.

[27]W. C. Van Deventer. "Individualized instruction in a basic science course." *Science Education* 30:269; December 1946.

included programs covering relatively long periods of time, programs providing for pacing according to ability, using an increased variety of materials in and outside the classroom, decreasing the emphasis on formal lectures and recitations, and increased emphasis on the teacher as a subject matter counselor. He concluded that individualized instruction involves a broadened conception of what laboratory work includes.[28] Baskin[29] in presenting and discussing models and means of increasing educational quality in higher education viewed independent study as a way of learning designed for all students and not as a special approach applicable only to the abler student. He noted that we critize "spoon feeding" college students and yet we continue to educate them in three and five hour packets. These credits for learning and the learning itself are often assumed to have a close relationship with the frequency with which a student enters a classroom.[30] Baskin[31] also pointed out that colleges and universities faced with an increasing number of students and pressed by the concerns for achieving quality have begun to examine their assumptions of the nature and organization of the teaching-learning process.

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[28]Ibid., p. 273.

[29]Samuel Baskin. Quest for Quality. New Dimensions in Higher Education Series # 7. Washington, D.C.: Office of Education, 1960. p. 1.

[30]Ibid., p. 2.

[31]Ibid., p. 1.

As early as May, 1959, a report of the Fund for the Advancement of Education[32] listed sixteen institutions which had been experimenting with the independent study approach as part of their regular classroom teaching procedures with all the students enrolled in a particular course. The students appeared to be able to learn as well with much less class time than is usually required of them.[33] McKeachie,[34] in discussing independent study, noted that if one goal of education is the development of the ability to continue learning after the end of a formal education, provision should be made for supervised experience in learning independently. Higher education has traditionally relied on teaching methods in which the teacher exercised a close control over the time and thinking of the student. In this highly directive procedure, the teacher often does more work than the students rather than liberating and directing the intellectual energies of the students.[35]

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[32]Fund for the Advancement of Education. Better Utilization of College Teaching Resources. A report by the Committee on Utilization of College Teaching Resources. New York: Fund for the Advancement of Education. May 1959. p. 18.

[33]Baskin, op. cit., p. 9.

[34]W. J. McKeachie. "Research on teaching at the college and university level." In: Handbook of Research on Teaching. N. L. Gage (ed.). Chapter 23, pp. 1118-72. New York: Rand McNally and Company, 1963. p. 1145.

[35]Howard E. Gruber and Morris Weitman. Self-directed Study: Experiments in Higher Education. Boulder, Colorado: University of Colorado. April 1962. p. 1-1.

Gruber and Weitman,[36] in reviewing the findings of independent study research at the University of Colorado at Boulder, noted that an educational environment is fundamentally hostile toward independent intellectual work on a student's part when the greater part of his time is spent in teacher directed activities.

Self-directed study programs have had a significant development in higher education as programs designed to increase a student's responsibility for his own education. Self-directed study programs preserve the course system while substantially reducing the proportion of time devoted to formal classroom meetings.[37] These programs are different from those methods ordinarily called independent study in that the one teacher-one student relationship is not maintained. This may allow for more economical use of an instructor's time.

If intellectual independence is considered to be an aspect of individual growth, it is important to know when an individual is ready for self-directed study. Gruber and Weitman,[38] in a general psychology course, found that in final examination performance sophomore students benefited

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[36]Howard E. Gruber and Morris Weitman. "The growth of self-reliance." School and Society 91:223; May 4, 1963.

[37]Gruber and Weitman. Self-directed Study: Experiments in Higher Education. loc. cit.

[38]*Ibid.*, p. 23-7.

more than freshmen from self-directed study, as evidenced by posttest scores, but that, in change in attitude toward intellectual work, the freshmen gained from exposure to self-directed study while the sophomores did not. On the basis of this finding, Gruber and Weitman concluded that, "Self-directed study may be best introduced in the freshman year, not because it leads at once to better performance, but because it leads to the most rapid change in educational values".[39] Hatch,[40] in reviewing the research on independent study, supported the findings of Gruber and Weitman and concluded that the right time for exposure to independent study is the first course taken at the university and the right way is to be very matter of fact about student involvement in the program. Hatch also stated that independent study programs begun at a later time in a student's college program have been disappointing because these "students had become so spoiled by spoonfeeding that they could not be persuaded to do with good grace what freshmen did, and did well, without persuasion".[41]

Baskin and Churchill, at Antioch College, found "no evidence that the independent study methods needed to be

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[39] Ibid.

[40] Winslow R. Hatch. Approach to Teaching. New Dimensions in High Education Series # 14. Washington, D.C.: Office of Education, 1966. p. 35.

[41] Ibid.

reserved for the superior or advanced student only".[42] Gruber and Weitman[43] also found little or no support for a direct relationship between ability and capacity to profit from self-directed study in nineteen courses at the University of Colorado, Boulder. In a general psychology course, where an interaction was present between ability and performance, the higher ability students seemed to have profited from directed study. However, the results did not indicate that the lower ability students were handicapped by the exposure to self-directed study. In a physical optics course, Gruber and Weitman[44] found that lower ability students profited the most from an exposure to self-directed study especially if they had a high academic aspiration level. They reasoned that some high ability students may have learned how to succeed in their college work without really trying and may become particularly handicapped when faced with an instructional method different from what they are accustomed. An independent study program at Vanderbilt University[45] involved a reduction of class time by from

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[42]Samuel Baskin and Ruth Churchill. "Experiment in independent study." In: "Antioch College reports". No. 2, 1961. p. 4.

[43]Gruber and Weitman, op. cit., p. 23-8.

[44]Ibid., p. 23-8,9.

[45]Vanderbilt University. "A report on the Vanderbilt University experiment." Nashville, Tennessee: Vanderbilt University, Summer 1958. p. 6.

twenty-five to fifty per cent. The conclusion reached was that students of average or superior ability performed and learned as well on the reduced schedule as on a standard schedule. The students believed that the experience had a beneficial effect on their study habits and the majority estimated they had not learned less than they were accustomed to under conventional classroom arrangements.

Parsons,[46] in a child development course involving upperclassmen at the University of Michigan, found that independent study appeared to be an effective technique for the learning of facts from a textbook. Kersh,[47] at the University of Oregon, and Parsons[48] noted that self-directed study fostered an increased retention ability as evidenced on posttest scores of achievement. Gruber and Weitman,[49] in discussing the results of the study in a general psychology course, suggested that self-directed study initiates a struggle within students for them to develop the ability to carry out independent study and then, if successful, a

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[46]Thomas S. Parsons. "A comparison of instruction by kinescope, correspondence study, and customary classroom procedures." Journal of Educational Psychology 48:40; January 1957.

[47]Bert Y. Kersh. "The adequacy of 'meaning' as an explanation for the superiority of learning by independent discovery." Journal of Educational Psychology 49:292; October 1958.

[48]Parsons, loc. cit.

[49]Gruber and Weitman, op. cit., p. 15-8.

struggle with the subject matter itself. The effect, they pointed out, seems to be more permanent after self-directed study than after listening to a lecturer who is often far more diligent than his students. Kersh,[50] in referring to his study with college students at the University of Oregon, suggested that if the learner is forced to rely on his own cognitive capacities, motivation may more likely be present to continue the learning process or to continue practicing the task after the learning period. As a result, learning transfer is much more effective than when the learner is not so motivated.

Very little difference in academic achievement between students working independently and those taught in conventional classes was reported by Churchill,[51] at Antioch College, McCollough and Van Alta,[52] at Miami University, and by the Antioch[53] and Oberlin[54] studies. Goldstein,[55] at

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[50]Kersh, loc. cit.

[51]Ruth Churchill. "Preliminary report on the reading plan study." Yellow Spring, Ohio: Antioch College, September 1957.

[52]Celeste McCollough and E. Locke Van Alta. "Experimental evaluation of teaching programs utilizing a block of independent work." Oxford, Ohio: Miami University, 1960.

[53]Antioch College. "Experiment in independent study." Yellow Springs, Ohio: Antioch College, 1950.

[54]Oberlin College. "Report on independent studies experiment at Oberlin College." Oberlin, Ohio: Oberlin College, 1957-58. p. 14.

[55]Avram Goldstein. "A controlled comparison of the project method with standard laboratory teaching in pharmacology." The Journal of Medical Education 31:373-74; June 1956.

Harvard Medical School, found that students taught pharmacology by a project method did not learn more than a control group taught in a standard laboratory. Novak,[56] in a study involving botany students at the University of Minnesota, found that students taught botany by the project method learned fewer facts than students in a conventional class did. Weitman and Gruber[57] reported that students, in freshman English, physical optics, and educational psychology, spending a part of their class time in independent groups without an instructor were superior to students in conventional classes in the ability to make difficult applications, in learning new materials, and in illustrating curiosity. Timmel[58] found no difference in the effectiveness of the lecture and project methods in changing the adjustment status of mental hygiene students.

Gruber and Weitman,[59] in reviewing studies of freshman English, physical optics, and chemical engineering

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[56]Joseph D. Novak. "An experimental comparison of a conventional and a project centered method of teaching a college general botany course." The Journal of Experimental Education 26:229; March 1958.

[57]Morris Weitman and Howard Gruber. "Experiments in self-directed study: effects on immediate achievement, permanence of achievement and educational values." Boulder, Colorado: University of Colorado, 1960.

[58]Gustave Bernhardt Timmel. "A study of the relationship between methods of teaching a college course in mental hygiene and a change in student adjustment status." Dissertation Abstracts 15(1):90; 1955.

[59]Gruber and Weitman, op. cit., p. 23-4,5.

courses, stated that students who are not novices in the subject area in which they are working are more successful studying independently than those who are novices. They suggested that the non-novice has a collection of "models of thought and study". He apparently has sufficiently internalized these from his previous experience for them to be helpful in a self-directed study program within a subject that he has been shown how to study. These models do not seem to be sufficiently general to permit an attack on a new field independently.[60]

Gruber and Weitman, in several psychology courses, found that "self-directed study increased the student's curiosity about the subject studied, as measured by the rise in questioning behavior. . . ."[61] In one group of seven courses where unfavorable evaluations of the self-directed courses were given, the students placed an increased emphasis on the value of doing independent intellectual work.[62] Hovey, Gruber, and Terrell,[63] in a study of two educational psychology courses, noted that although there is no obvious reason to expect independent study to produce better results on a final exam this may be expected if a greater interest

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[60]<u>Ibid</u>.

[61]<u>Ibid</u>., p. 23-5.

[62]<u>Ibid</u>.

[63]Donald Hovey, Howard E. Gruber, and Glenn Terrell. "Effects of self-directed study on course achievement, retention, and curiosity." <u>The Journal of Educational Research</u> 56:346; March 1963.

and curiosity is generated by independent study. They found the small group discussion approach to be associated with an increase in curiosity among students.[64] Mason and Angell,[65] studying a biological science course at Michigan State College, found the discussion technique, in which the students initiated the questions, especially effective while the technique was new and that the interest or effort decreased as the term progressed.

Morale problems with experimental groups have been reported by Eglash,[66] in introductory college psychology classes, Neel,[67] in a required psychiatry course with medical students, Beach,[68] in a social psychology course, Baskin and Churchill,[69] at Antioch College, and Gruber and Weitman,[70] at the University of Colorado at Boulder. Eglash[71] and

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[64] Ibid., p. 351.

[65] John M. Mason and George W. Angell. "The improvement of general education courses in college biology." School and Society 80:90; September 18, 1954.

[66] Albert Eglash. "A group-discussion method of teaching psychology." Journal of Educational Psychology 45:267; May 1954.

[67] Ann F. Neel. "The relationship of authoritarian personality to learning; f scale scores compared to classroom performance." Journal of Educational Psychology 50:198; October 1959.

[68] L. R. Beach. "The use of instructorless small-groups in a social psychology course." Paper read at Western Psychological Association, Seattle, Washington, June 1961.

[69] Baskin and Churchill, op. cit., p. 4.

[70] Gruber and Weitman, op. cit., p. 23-6.

[71] Eglash, loc. cit.

Beach[72] reported that the initial negative reaction to methods of instruction, in which students are given a greater independence than they are accustomed, may give way to a more favorable attitude during the experimental course. Neel,[73] Baskin and Churchill,[74] and Gruber and Weitman[75] reported a somewhat unfavorable student reaction even at the end of a directed study course. Gruber and Weitman[76] discussed these unfavorable student reactions in light of the development of a more positive attitude toward independent intellectual work and suggested the occurrence of the following sequence of events: (1) the initial exposure is unpleasant because it is a change from accustomed and comfortable teaching methods, (2) the student's experience with various teaching methods leads him toward an attitude which is more accepting of individual study, (3) the initial reactions persist even though the underlying attitudes have been changed by exposure to the new method, and (4) a new set of expectations must be adopted before maximum benefit can be anticipated from self-directed study. A theoretical formulation of this sequence has been offered by Festinger,[77]

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[72]Beach, _loc_. _cit_. [73]Neel, _loc_. _cit_.

[74]Baskin and Churchill, _loc_. _cit_.

[75]Gruber and Weitman, _loc_. _cit_.

[76]_Ibid_., p. 23-6.

[77]L. Festinger. _A Theory of Cognitive Dissonance_. Evanston, Illinois: Row, Peterson, 1957. In: Gruber and Weitman, _ibid_.

who indicates that individuals respond to "dissonance" between opinions and required actions by changing their opinions to reduce the dissonance. Festinger and Carlsmith[78] substantiated the theory and found that the greatest opinion change occurred when the pressure used was just sufficient to produce the overt behavior. Greater pressure produced smaller changes in opinion. The rate of progress through the attitudinal and behavioral changes in adjusting to self-directed study may depend on variations in teacher behavior, the degree to which the program varies from institutional norms, and factors affecting the felt amount of pressure toward the change.[79]

A commonly advanced hypothesis related to achievement is that students with a high need for independence will do better in situations which allow for an increased opportunity for independent work.[80] This hypothesis was not supported by Koenig and McKeachie,[81] in an elementary psychology course at the University of Michigan. In an eighth grade group, Amidon and Flanders[82] found that dependent-prone children

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[78]L. Festinger and J. M. Carlsmith. "Cognitive consequences of forced compliance." Journal of Abnormal and Social Psychology 58:209; March 1959.

[79]Gruber and Weitman, *loc. cit.*

[80]*Ibid.*

[81]Kathryn Koenig and W. J. McKeachie. "Personality and independent study." Journal of Educational Psychology 50:134; June 1959.

[82]E. Amidon and N. A. Flanders. "The effects of direct and indirect teacher influence on dependent-prone students learning geometry." Journal of Educational Psychology 52:290; December 1961.

learned more from teaching methods involving less direction than from more directive methods. The independent-prone students did not seem to be affected by this teaching method variable. Koenig and McKeachie,[83] supported these findings.

Bendig and Hountras,[84] in undergraduate and graduate educational psychology classes at the University of Pittsburgh, found that the authoritarian student would be happier in well structured courses. Gruber and Weitman,[85] in the review of their studies at the University of Colorado, reported that students who have a high regard for independent intellectual work tend to do better work in self-directed study programs. These students also gave a more favorable course evaluation in self-directed study groups than if they were in conventional groups.

Gruber summarized the research on self-directed study by emphasizing two major findings:

> First, when the criterion for evaluating self-directed study is the student's learning of subject matter, the results are indeterminate, producing no very powerful argument for or against self-directed study and no argument for or against conventional methods such as lecture courses meeting two or three times per week.
>
> Second, when the criterion for evaluation of self-directed study is a group of attitudinal changes such as increased curiosity, critical thinking, and attitude

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[83]Koenig and McKeachie, loc. cit.

[84]A. W. Bendig and P. T. Hountras. "Anxiety, authoritarianism, and student attitude toward departmental control of college instruction." Journal of Educational Psychology 50:6; January 1959.

[85]Gruber and Weitman, op. cit., p. 23-7.

> toward independent intellectual work, brief experiences with self-directed study do typically produce small, favorable changes.[86]

Gruber suggested that certain attitudinal behaviors are a necessary prequisite to stable changes in intellectual work habits. Campbell,[87] in examining self-directed study and programmed instruction for different learning objectives, indicated that changes in attitudes and work habits must precede self-directed study if an improved learning of substantive material is to result. His findings also noted the need for specific training in developing new patterns of active intellectual work and enabled him to conclude that, "the first obstacle to be removed in making self-direction successful is the student's strong habit of passive acquiescence".[88]

Audio-tutorial learning -- a systems approach. Springer[89] states that, "A rational systematic approach to education can promote greater innovation because it produces

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[86]Howard E. Gruber. "The future of self-directed study." In: Winslow R. Hatch and Alice L. Richards (eds.). Approach to Independent Study. New Dimensions in Higher Education # 13. Washington, D.C.: Office of Education, 1965. p. 1.

[87]V. N. Campbell, "Self-direction and programed instruction for five different types of learning objectives." Technical report AIR-D10-12/63 TR(b). Palo Alto, California: American Institute for Research, December 1963. p. 16.

[88]Ibid.

[89]C. H. Springer. "The 'systems' approach." Saturday Review 50:56; January 14, 1967.

continuous dynamic modifications". Eraut,[90] in considering a course as an instructional system, noted that the purpose of course development is to design validated instruction guaranteed to guide learners with the required initial knowledge toward the instructional system's output specification. Students who use the system in its developmental phases may not meet these criteria, but the information gained will allow system revision and redesign. Phillips[91] considered the aims of a systems approach as a restatement of the ends, means, and concerns of educational philosophy in terms of an application of resources to the attainment of system objectives.

Audio-tutorial instruction. Audio-tutorial instruction involves a multimedia approach. A wide variety of teaching-learning experiences are integrated to effectively present some important aspect of a subject. The taped program is not a lecture, but an attempt to provide a one-to-one relationship between the student and teacher originating as a way of aiding students toward expected learning outcomes. Postlethwait[92] stated that the three sessions used

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[90]Michael R. Eraut. "An instructional systems approach to course development." AV Communications Review 15:92; Spring 1967.

[91]Murray G. Phillips. "Learning materials and their implementation." Review of Educational Research 36:374; June 1966.

[92]S. N. Postlethwait. "Teaching and technique: an audio-tutorial approach to teaching." Pacific Speech 1:58-59; May 1967.

to implement the audio-tutorial system, in a botany course at Purdue, provide the personal attention important for student motivation. In answering questions related to the opportunity given students for inquiry, he defined the levels of inquiry and noted that the system allows inquiry at all of the levels. He reported positive results in the audio-tutorial approach from several points of view. "Better instruction can be given with equal or less staff and space. Grades and student interest have improved. Costs are reduced for equivalent levels of instruction."[93]

Keislar and McNeil,[94] in working with first grade pupils, found that auto-instructional features permitted a consistency of instruction. McNeil and Keislar[95] found that students of lower and higher mental ability are distinguishable in terms of criterion performance calling for transfer of principles even though nearly all children display evidence of profit from instruction at the primary grade level. Doty,[96] at the college level in an introductory

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[93]*Ibid*., p. 59.

[94]Evan R. Keislar and John D. McNeil. "Teaching scientific theory to first grade pupils by auto-instructional device." *Harvard Educational Review* 31:75; Winter 1961.

[95]John D. McNeil and Evan R. Keislar. "Individual differences and effectiveness of auto-instruction at the primary grade level." *California Journal of Educational Research* 12:163; September 1961.

[96]Barbara A. Doty. "Teaching method effectiveness in relation to certain student characteristics." *The Journal of Educational Research* 60:364; April 1967.

psychology course, found that students performing best under taped lecture conditions had low social needs, moderate achievement need, and were low in creativity. High GPA and achievement need students performed well under all instructional methods.[97] Underwood[98] noted the following desirable features of audio-instructional programs: (1) students can use the laboratory at their own convenience and take as much or as little time as needed, (2) students are forced to work on their own with help from a laboratory instructor. Banks[99] presented the following problems with a general college chemistry course implemented as an auto-instructional program: (1) the basic-educational problem of student self-discipline remains, (2) programmed courses are at a certain disadvantage with courses having deadlines in competition for a student's time, (3) if extra reading is required the slow reader is decidedly handicapped, and (4) the habitual malingerer finds the chance to neglect the program irresistable. Umstattd,[100] from a study in the College of Education at the University of Minnesota, reported that the loss of time due to a lack of

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[97]Ibid., p. 365.

[98]David L. Underwood. "Creativity in instruction." Audio-Visual Instruction 12:682; September 1967.

[99]James E. Banks. "Evaluation of an auto-instructional program in general college chemistry." Journal of Research in Science Teaching 1(4):351-52; 1963.

[100]J. G. Umstattd. "Students appraisal of independent study." The Journal of Higher Education 6:240; May 1935.

understanding of the aims of a program and the requirements are other disadvantages.

Postlethwait, Novak, and Murray [101] at Purdue reported a positive relationship between time spent in an audio-tutorial carrel and total posttest scores. When grouped by analytic ability, it was noted that the knowledge gained for the middle analytic group was greater for a given amount of study time than the higher group. Although the high analytic group spent less time in the session their mean scores were higher than the scores of the middle analytic group who worked more than twice as long in the carrel. Wash,[102] using programmed materials in teaching high school chemistry, also reported a positive relationship between time spent in a programmed sequence and achievement.

Advanced placement programs. Advanced standing or placement programs are described by Radcliffe as a college "pattern which enables superior students to receive appropriate placement, credit, or both on the basis of college level courses they have taken in high school".[103] A broad

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[101] S. N. Postlethwait, J. Novak, and H. Murray. An Integrated Experience Approach to Learning with Emphasis on Independent Study. Minneapolis, Minnesota: Burgess Publishing Company, 1964. p. 103.

[102] James Alexander Wash, Jr. "An experiment in the use of programmed materials in teaching high school chemistry." Dissertation Abstracts 26(2):915; 1965.

[103] Shirley A. Radcliffe. Advanced Standing. New Dimensions in Higher Education Series # 8. Washington, D.C.: Office of Education, 1961.

conception of the function of a placement program is that of planning educational experiences that contribute to the further development of a student. This kind of curricular plan is geared to supplement a student's earlier training, not repeat it.[104] Bloom and Allison[105] reported that placement programs are necessary because entering college students have heterogeneous educational and experiential backgrounds. Students coming from a variety of high schools show very little uniformity in their former course patterns. Students with equal intellectual abilities may be on entirely different levels of subject matter exposure.[106] Entering college students also differ with respect to the kinds and amount of independent reading and study that may have been required of them.[107] The determination of the level of student competence from records and transcripts of previous work may almost be impossible. According to Bloom and Allison,[108] when the courses in college are quite different from the courses the student may have had in secondary school the

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[104]Benjamin Bloom and Jane M. Allison. "Developing a college placement test program." The Journal of General Education 3:214; April 1949.

[105]*Ibid*., p. 211.

[106]Postlethwait, Novak, and Murray, *op*. *cit*., p. 2.

[107]Bloom and Allison, *op*. *cit*., p. 211.

[108]*Ibid*., p. 215.

problem is further complicated. We simply should not assume a student is educated because he has passed prescribed courses or has accumulated a fixed number of credits.

Credit by examination seems to be older and broader in scope than advanced placement. Exemption examinations usually aim to cover only course essentials. There is no assurance that exempted students would be able to hold their own in competition with a superior student who has completed specific course materials.[109] If exemption is to be given, the depth of the examination should satisfy the faculty and students that they have deserved exemption. In addition to the exemption feature, the examinations may make it possible to detect many students who are likely to fail regular course examinations if given only the regular instruction in a course.[110]

Bloom and Allison[111] also noted that colleges seem to emphasize achievement levels and demonstrated competencies rather than the manner in which this background was attained. The educational development of individuals through educational development outside the school may extend far beyond the requirements of a certain course. Placement programs

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[109]Lily Detchen. "A program of required exemption examinations." The Journal of Higher Education 24:249; May 1953.

[110]Bloom and Allison, op. cit., p. 215.

[111]Ibid., p. 211-12.

should have some definition of levels of competence as well as some stable technique for determining when that level of competence has been reached.

The College Entrance Examination Board[112] Committee for the Advanced Placement Examination in Biology has been interested in encouraging secondary schools to provide college level courses for their best students. The Committee has provided a course description for the use of teachers planning to meet the objectives of college biology courses in high schools. The Advanced Placement Examination is based on the suggested course description. Colleges and universities are encouraged to give advanced placement to students who are successful on the examination.[113] Major concern centers around whether these compromise examinations can measure the level of student achievement provided by so diverse an array of high school programs. Abraham and Grobman[114] were concerned that misassignment of students in collegiate biology and cognate courses may result if specific high school programs are not considered in the testing programs.

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[112]College Entrance Examination Board. Princeton, New Jersey.

[113]Claude W. Gatewood and Ellsworth Obourn. "Improving science education in the United States." Journal of Research in Science Teaching 1(4):386; 1963.

[114]Norman Abraham and Arnold Grobman. "The biology achievement tests of the college entrance examination board and BSCS biology." News and Views of NABT 9:1-3; April 1965.

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Lewis[115] reported that credit by examination gives flexibility to curriculum programs without necessitating or encouraging changes in them. Rothwell[116] suggested that the advanced placement program is purely an interim measure that treats symptoms rather than ailments. Detchen[117] stated that students are often modest or fear failure on exemption examinations. Successful students are usually quite ready to omit courses through exemption programs.[118] Bloom and Allison[119] concluded that placement tests can serve as the basis for assembling placement evidence when consideration is given to the relevant kinds of competence which a student may attain.

Summary. A review of the literature revealed that curriculum revision in biology at the college and university level may involve change in the content presented and the innovative techniques used. The core curriculum concept in biology featured content which is appropriate to all biology students. The curricular changes themselves are not easily effected since opinions as to what a curriculum should

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[115] Lanora G. Lewis. The Credit System. New Dimensions in Higher Education Series # 9. Washington, D.C.: Office of Education, 1961.

[116] C. Easton Rothwell. "From high school to college: new problems in adaptation in the high school curriculum." Journal of Secondary Education 37:236; April 1962.

[117] Detchen, loc. cit. [118] Ibid.

[119] Bloom and Allison, op. cit., p. 215.

contain are so varied. The changes result from continued efforts at all staff levels with administrative support.

Efficient and better educational programs may be simultaneously attainable through innovative changes in a curriculum. The changes may facilitate an increase in the credit productivity of an instructional staff by decreasing the average number of student contact hours required to reach course objectives. Curricular change is not new, but the changes should involve educational method as well as biology content.

The research on educational programs which reduce the number of classroom contact hours showed that students of various abilities learn as well as they might in conventional classes. Baskin (30),[120] Baskin and Churchill (43) and Gruber and Weitman (44) citing research at the college level found no evidence that independent study methods should be reserved for superior or advanced students. At Vanderbilt University (46), average and superior ability students performed and learned as well on a reduced class schedule as on a regular one. Gruber and Weitman (44) found that while higher ability students seemed to have profited from independent study, lower ability students were not handicapped. Gruber and Weitman (45) also found that the lower ability students profited most if they had high

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[120]The number in parentheses refers to previously cited references.

academic aspiration levels. McNeil and Keislar (94) at the primary school level were able to distinguish higher and lower ability students in terms of a criterion performance calling for a transfer of principles although all students profited from the instruction.

The most effective learning results appear to occur when college students are reoriented upon their arrival at college not to look for success in academic work through random efforts to learn all there is to know. The attempt to inculcate new patterns of intellectual work may have to be a deliberate one until intellectual self-reliance becomes a student tradition. According to Gruber and Weitman (39), sophomores benefited more from self-directed study than freshmen, as evidenced by posttest scores, but that the freshmen illustrated attitudinal changes while the sophomores did not. Hatch (41) concluded the best time for students to begin independent study at college is as freshmen.

The studies of Churchill (52) and McCollough and Van Alta (53), showing that independent study programs resulted in few significant differences in achievement when compared with regular college courses, were confirmed in the Antioch (54) and Oberlin (55) reports. Gruber and Weitman (58) found that independent study groups were superior in the ability to make difficult applications and that (60) better results occur when the students are not novices

in the subject area using the approach. Kersh (48) and Parsons (49) found that self-directed study fosters an increased ability to retain facts presented in a book. Goldstein (56) and Timmel (59) found no difference in achievement in lecture and project method courses while Novak (57) reported that project method students learned less.

Self-directed study programs appear to foster desirable attitudinal changes. Gruber and Weitman (61) in reviewing the research on self-directed study noted that these programs increased student curiosity. Hovey, Gruber, and Terrell (64) found that small group discussion sessions are associated with an increased student curiosity. Mason and Angell (65) found the group discussion technique in which the students initiated the questions especially effective early in a school term, but noted that the student interest or effort decreased throughout the term.

Student personality factors appear to influence student performance in self-directed study programs. Doty (95) found that low social need students, moderate achievement need students, and students low in creativity performed best under taped lecture conditions. That students with a high need for independence do better in independent study programs was not supported by Koenig and McKeachie (80). Doty (96) also reported that high grade point average and high achievement need students perform well under all educational methods. Gruber and Weitman (85) found that students with a high regard for independent intellectual work tend to do better in self-directed study programs. Bendig and Hountras (84) found authoritarian students happier in well structured courses and Koenig and McKeachie (83) noted that students who thought the teacher should be authoritarian did poorly in independent study. Amidon and Flanders (82) found that eighth grade dependent prone children learned more in teaching methods involving less direction.

Eglash (71) and Beach (72) reported that initial morale problems existed within programs giving greater independence to students, but noted that these problems gave way to more favorable attitudes later in the programs. Neel (73), Baskin and Churchill (74), and Gruber and Weitman (75) reported a somewhat unfavorable reaction even at the end of an independent study course.

Time spent in an instructional program appears to be somewhat related to posttest achievement scores. Postlethwait, Novak, and Murray (100) reported a positive relationship between time spent in an audio-tutorial carrel and posttest score achieved. Wash (101) reported similar findings in a high school classroom situation involving programmed sequences.

The review of the literature related to advanced placement programs indicated that students should not be forced to repeat course materials with which they have become familiar through experiences inside or outside the school. The review also showed that advanced placement, advanced credit, and exemption programs do provide some flexibility in a curriculum without changing the curricular program and in so doing may treat symptoms rather than ailments. Exemption or waiver examinations are generally of value in determining student proficiency, according to the literature, and are recommended as aids in planning the further educational growth of students.

CHAPTER III

THE INTRODUCTORY BIOLOGY COURSE

This chapter includes a treatment of the establishment of Lyman Briggs College at Michigan State University and background information concerning the development of the introductory course in biology for the College. The chapter also describes the course as evaluated in the winter term, 1969.

Lyman Briggs College. Michigan State University established Justin Morrill College, its first residential college, in 1965. This College was established in order to provide a curriculum which emphasized international and cross-cultural studies as a feature of an overall liberal education. The success of this college was instrumental in the establishment of two similar semi-autonomous colleges, James Madison College, emphasizing the social sciences, and Lyman Briggs College, emphasizing the biological and physical sciences and mathematics in their respective curricular programs.

The first official action toward the establishment of Lyman Briggs College occurred when the Michigan State University Board of Trustees, on October 20, 1966, authorized the formation of a planning committee to develop a curriculum appropriate for a broad liberal program in the sciences and mathematics. Members of the university faculty appointed by the Provost to serve on the planning committee for the College were: Dr. Frederic B. Dutton, Chairman; Dr. John E. Cantlon, Botany; Dr. James L. Fairley, Biochemistry; Dr. Frederick H. Horne, Chemistry; Dr. Gerhard D. Linz, Counseling Center; Dr. Lee S. Shulman, Education; Dr. Marvin L. Tomber, Mathematics; Dr. Emanuel Hackel, Natural Science; Dr. Gerald J. Massey, Philosophy; Dr. Harold T. Walsh, Philosophy; Dr. Michael J. Harrison, Physics; Dr. Richard Schlegel, Physics; Dr. William Stellwagon, Psychology; and Dr. Bruce R. Poulton, Provost Representative.

Lyman Briggs College formally came into existence on July 1, 1967, and Dr. Frederic B. Dutton was named Dean of the College. The College was named Lyman Briggs College in the memory of a distinguished alumnus of Michigan State University. Dr. Lyman J. Briggs was the long-time director of the Federal Bureau of Standards and the initial director of the Manhattan Project during World War II.[1] The first class of students was admitted for the fall term, 1967. The original planning committee has been supplemented with other university faculty members and continues to serve the

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[1]Lyman Briggs College. "Lyman Briggs College newsletter." Vol. 2, No. 2. East Lansing: Lyman Briggs College, Michigan State University, n.d. p. 6. (Mimeographed.)

College and its students in an advisory capacity as College Fellows.

The college curriculum. The Lyman Briggs Planning Committee in their deliberations regarding the College curriculum noted that the criticism of higher education in the sciences focused on at least two major areas of concern:

1. The failure of students in the sciences to develop equally in human terms so that they may perceive ends as well as means, and

2. The rigid bulk of technical detail required in curricula designed to serve potential professional 'specialists'.[2]

The committee attempted to recognize these two criticisms by providing an education in the sciences which is balanced by the components of a liberal education.[3] The core curriculum was designed to provide such a balance with the following features:

1. A sound foundation in the Biological and Physical Sciences and Mathematics.

2. A unique general education arranged to focus attention to the relationships between science and society and science and man.

3. Fields of concentrated study which seek to develop high levels of scholarship and the qualifications for useful citizenship, graduate study, secondary school teaching, or entry into business, industry, or government services.[4]

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[2]Lyman Briggs College Planning Committee. "A proposed program for Lyman Briggs College." Report to the Educational Policies Committee. East Lansing: Lyman Briggs College, Michigan State University, March 8, 1967. p. 2. (Mimeographed.)

[3]*Ibid.*

[4]*Ibid.*, p. 3.

Guidelines prepared by both the Planning Committee to the University Provost and the Educational Policies Committee provided the framework within which the College Planning Committee was to develop a proposed program of curricular implementation. The curricular program was to be appropriate for the following objectives established for the College:

> First, provision for general education in addition to the sciences, by means of instruction in English rhetoric, foreign languages, social sciences, and humanistic studies.
>
> Second, an education on a university level in the elements of mathematics, chemistry, physics, and biology, sufficient to give graduates of the College a sound* understanding of these sciences and of relationships between them.
>
> Third, attention to the historical, philosophical, and social aspects of sciences, through formal course work and occasional lectures, seminars, and informal discussions to significantly relate science to society and to man.
>
> Fourth, concentration in some one science, or related science providing a field of concentration and interest (equivalent to a major) so as to give preparation for professional work, graduate study, administration in science based industry, business, or government service, or secondary school teaching.
>
> Fifth, a concern through student advising and curricular flexibility for the individual interests and potentialities of each student.
>
> Sixth, the attainment of the advantages of a small, cohesive residential college community with use at the

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*By a sound foundation is meant the acquisition of the knowledge, the understanding of basic principles and ideas and theoretical structures and the development of skills that are prerequisites to the opportunity for a choice of a field of professional or vocational endeavor.

same time of the resources of a large, multi-faceted university.[5]

The adopted core curriculum shown in Table II includes a program of courses which meet the general education requirements of the University and give special attention to the problems in science as they affect society. The field of concentration which a student selects in Lyman Briggs College corresponds to a major chosen in departmentally organized colleges. Table III shows a sample distribution of credits for a student's college program in Lyman Briggs College.

An entirely new interdisciplinary approach for curriculum building was recommended by the Lyman Briggs College Planning Committee. The Committee also proposed that initial efforts, in a systems approach to educational instruction, be centered in the biological and physical sciences to ". . . search for new and better ways for Michigan State University and higher education in general to meet its objectives".[6]

Students at Lyman Briggs College. Lyman Briggs College is open to any student who meets the general university requirements and desires to enroll in the College. Each

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[5]Lyman Briggs College. "Program planning handbook." East Lansing: Lyman Briggs College, Michigan State University, Fall 1968. p. 2. (Mimeographed.)

[6]Lyman Briggs College Planning Committee, "A proposed program for Lyman Briggs College," op. cit., p. 9.

Table II. Core curriculum for all students in Lyman Briggs College.[a]

Course Area	Quarter Credits
Mathematics (thru LBC 113-Calculus II)	15
Computer Science	3
Chemistry[b]	8
Physics[b]	12
Biology[b]	10
Social Sciences	12
Humanities	12
Logic, History and Philosophy of Science	12
Third Culture Rhetoric	6
Senior Seminar	9
Total credits	99

[a]Taken in part from "Lyman Briggs College 1968-1969." A college brochure. East Lansing: Lyman Briggs College, Michigan State University.

[b]Credits may be earned in a variety of sequences.

Table III. Sample credit distribution for all students in Lyman Briggs College.[a]

Curriculum Area	Quarter Credits
Core Curriculum (Including 51 credits general education)	99
Physical Education	(3)[b]
Field of Concentration	32
Electives	49
Total credits	180

[a]Taken in part from "Lyman Briggs College 1968-1969." A college brochure. East Lansing: Lyman Briggs College, Michigan State University.

[b]Physical Education credits are not included in the total credits to be earned in Lyman Briggs College.

freshman class is expected to be limited to four hundred students and the anticipated maximum enrollment for the entire College may approach twelve hundred students. The first class at the College enrolled two hundred twenty-four individuals. For the fall term, 1968, the total enrollment was four hundred twelve students. The College program is designed for students:[7]

1. Interested in a broad field of concentration in one of the physical or biological sciences and mathematics as preparation for entry into graduate work in a single science or indisciplinary fields.

2. Seeking pre-professional scientific training leading into such areas as medicine, dentistry, patent law, science writing, history and philosophy of science, administration and management in science-based industries, and government service.

3. Interested in science but wish to defer their choice of specialization until later in their upper-class or graduate experiences.

4. Seeking certification as secondary school science teachers.

<u>The introductory course in biology--Lyman Briggs College 140</u>. The introductory biology course as evaluated during the winter term, 1969, was designed to provide for group instruction by lecture-question-discussion techniques and for individual learning experiences through an audio-tutorial approach. Three different kinds of situations were provided in order to implement instruction. All students

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[7] *Ibid*., p. 4.

met for fifty minutes a week in a lecture-like situation. In this situation, major concepts or current topics were discussed by senior staff members, films were shown, guest lecturers spoke, and examinations were administered. The students were also scheduled to meet in groups of approximately ten students for a fifty minute period each week for a recitation and response session. These sessions were handled by senior staff members or graduate assistants.

Another kind of situation was provided by the maintenance of carrels for nonscheduled, individual study use by the students. The nonscheduled, individual study session facilities were supervised by Briggs College students who had previously taken the course. These individuals were responsible for maintaining the facilities and for assisting students.

In order to familiarize the students with the procedures to be followed in the course and the rationale for organizing and implementing the various aspects of the course, a handout was distributed with the study guide materials at the first large assembly session of the term. This handout is included in Appendix D.

Development of the course content. The responsibility for developing the beginning course was assumed by Drs. Howard Hagerman and Jack Elliott during the summer term, 1967. In planning the course content, subject matter concepts and principles were selected and situations were provided for implementing the overall objectives for the course. These objectives, with respect to student acquisition and behavior were: (1) to become familiar with or aware of systems ecology-organism oriented, and (2) to become familiar with representative organisms in ecosystems-plants and animals in the environment. The proposed subject matter units[8] and the time allotments for the first offering of the course in the winter term, 1968, are shown in Table IV.

A tremendous amount of work was required to assemble the necessary materials to implement these units. Scripts were written, master tapes cut to organize and integrate the planned experiences, and study guides prepared to assist the students in their study. A representative study guide is shown in Appendix E. Two graduate assistants helped in planning experiments, gathering materials, and organizing displays. Carousel projectors, tape decks, microscopes, carrels, and all necessary laboratory materials had to be purchased. Two by two slide sequences paralleling the taped program were also produced. In most cases, these slide sequences were duplications of printed materials and slides from the personal collections of staff members. Charts and graphic materials were prepared by the Instructional Media Center at Michigan State University.

The investigator assumed the responsibility of preparing and collecting test items suitable for the materials and

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[8]These units were later designated packages in the development of the program.

Table IV. Proposed LBC 140[a] Biology course

Unit	Time in Weeks	Topic
I	1	The Terrestrial Ecosystem. A. Levels of organization. B. Primary examples (Sanford Woodlot and Eastern Deciduous Forest).
II	1	The Seed Plants - Life Cycle and Morphology. A. Angiosperms and Gymnosperms. B. Adaptations of seed plants.
III	1	Higher Animal Life Cycle and Morphology. A. Chordate. B. Adaptations of selected chordates.
IV	1	The Aquatic Ecosystem. A. Lake Stratification. B. Trophic levels and biological factors. C. Physical factors.
V	1	Phytoplankton. A. Life cycles and methods of reproduction of selected phytoplankton. B. Adaptations.
VI	1	Zooplankton. A. Life cycles and reproduction of selected zooplankton. B. Adaptations.
VII	1	Systems of Classification - Plants A. Taxonomic principles B. Evolutionary trends.
VIII	1	Systems of Classification - Animals. A. Taxonomic principles. B. Evolutionary trends.
IX	1	Populations - Human Factors in the Ecosystem. A. Man's place in nature. B. Man's responsibility as a social animal in systems ecology.

[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

experiences which were planned for the course programs. These materials were planned, developed, and evaluated over a period of fifteen months for the purpose of testing students during the winter term, 1969, when the study being described was undertaken.

Time did not permit the preparation of all of the proposed units prior to the opening of the winter term, 1968. However, at the beginning of the winter term four units had been completed and others were nearing completion deadlines. Each content unit was planned for a week of student time appropriate for a three credit course. When the first unit was placed in the individual study session during the winter term, 1968, it satisfied the expected student time requirement. The second unit was extended on two occasions for additional study session time and the third unit was also rescheduled for a two week time block. The course content units offered during the winter term, 1968, are shown in Table V. The mean amount of time students spent in the individual study session is also shown. These data were most useful in determining the amount of time the materials were being used by students so that the course content and course experiences could be adjusted to keep the time requirements within reasonable limits.

While conducting the course program during the winter term, it became apparent that the entire program could not be implemented as proposed and major content revision began immediately after initial student use. The major changes

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Table V. Winter term, 1968, LBC 140 Biology course.

Unit	Time in Weeks	Topic	Mean Student Time in Individual Study Session per Week in Hours
I	1	The Terrestrial Ecosystem	3.03
II	3	The Flowering Plant in the Ecosystem	3.27
III	2	An Animal in the Terrestrial Ecosystem	4.44
IV	1	An Aquatic Ecosystem	3.25
V	1	Plant Life in an Aquatic Ecosystem	3.60
VI	1	Animal Life in an Aquatic Ecosystem	3.38

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involved a reduction of the number of examples used and the extent to which the remaining examples were discussed. Unit two, for example, was limited in revised tapes to a discussion of the sugar maple plant rather than all seed plants. Larger units were revised into smaller parts, while previously unused content materials were woven into other tapes.

Midway through the spring term, 1968, administrative approval was granted to permit a variable content-variable credit course format to be implemented. This allowed students to select some of the planned course content on an optional basis and extended the obtainable credit from three to four or five credit hours. Two course units were offered for optional credit and each was temporarily valued at one hour of credit. The option plan allowed the entire course content to be offered and gave each student some choice in the content that would be completed. The option plan also allowed students to reappraise their total credit hour load during the term and consider the possibility of increasing the amount of biology credit they could attain. These decisions were to be made after the student had completed the required course packages. The additional credit was offered in Lyman Briggs College 290--Special Problems. The optional packages could also be completed in any term following the completion of the required packages of the course. The units offered during the spring term and the individual study session mean completion times for the units are shown in Table VI. The completion of the seven required units offered three hours of credit. The selection of additional units allowed an extra hour of credit for each one selected.

For the fall term, 1968, ten taped programs and complementing study guides were available for student use. Three of the original units had been revised and reorganized into two part packages. Two of the original units became a single package and the two remaining units were redesignated content packages. Three of these packages were required of all students taking the course. The other three packages were optional packages although each student had to select at least one of these packages for the minimum of three term hours of credit. The course format as offered during the fall term, 1968, is shown in Table VII (p. 66). Additional carrels were also made available and a second room acquired to facilitate the placing of displays and demonstrations.

The preceding information has been presented to provide a background for an understanding of the audio-tutorial course which was studied during the winter term, 1969. The course program in use during this winter term evolved during three terms of student use and revision and reorganization in both the course content and course structure. The most extensive change that occurred during the term in which the course was investigated was the elimination of the oral quiz procedure that had existed in the recitation and response

Table VI. Spring term, 1968, LBC 140 Biology course.

Table VI. *Spring term, 1968, LBC 140 Biology course.*

	Scheduled Time in Weeks	Topic	Mean Student Time in Individual Study Session per Week in Hours
Required Units			
I	1	The Terrestrial Ecosystem	2.83
II	1	A Flowering Plant in a Terrestrial Ecosystem--The Primary Plant Body.	3.20
III	1	A Flowering Plant in a Terrestrial Ecosystem--The Secondary Plant Body and Reproductive Structures.	3.48
IV	1	A Vertebrate in the Terrestrial Ecosystem--Anatomy and Physiology of a Selected Vertebrate.	5.60
V	1	A Vertebrate in the Terrestrial Ecosystem--An Animal in Its Environment.	1.84
VI	2	An Aquatic Ecosystem	1.56
IX	2	Man in the Ecosystem	0.72
Optional Units			
VII		Plant Life in an Aquatic Ecosystem	3.26[a]
VIII		Animal Life in an Aquatic Ecosystem	2.83[a]

[a]Total time.

Table VII. LBC 140 Biology[a] course format for the fall and winter terms, 1968-69.

Package 1[b]		
Package 2	Required Packages	Two Credits
Package 3		
Package 4		
Package 5	Optional Packages[c]	One Credit Each[d]
Package 6		

[a]Lyman Briggs College Biology 140 has a <u>three</u> credit hour minimum. One optional package is selected in addition to the required packages taken.

[b]A description of the content included in each of the content packages is given in Appendix F.

[c]All selections are made during the third and fourth week of the term. By this time the student has had the opportunity to become familiar with the instructional approach and is aware of the content which is covered in each optional package.

[d]Lyman Briggs College 290 has a two credit per term maximum. One additional credit is given for each extra package selected.

sessions. Oral responses were not assigned grades after the fourth week of the term. The change was made to give the recitation and response session a somewhat informal structure in an attempt to foster a continuous pattern of student prompted discussion. The package materials have been briefly described in Appendix F. The course format used during the term in which the investigation was conducted is shown in Table VII (p. 66). Appropriate session schedules for the winter term, 1969, are shown in Appendix G.

Summary. An experimental, audio-tutorial course--Lyman Briggs College Biology 140--was offered for the first time at Michigan State University during the winter term, 1968. The course features a variable content-variable credit format in a curriculum effort to meet stated learning objectives in interesting and innovative ways. The content and structure of the course had evolved from three terms of student use when a research study was initiated in the course during the winter term, 1969.

CHAPTER IV

SOURCES AND TREATMENT OF DATA

This study collected data related to an audio-tutorial biology course in Lyman Briggs College at Michigan State University. The students in the study were those regularly enrolled in the course during the winter term, 1969. The study was initiated on January 6, 1969, at the first scheduled class held during the winter term, and terminated on March 12, 1969, the day of the scheduled final examinations.

Data from one hundred thirty-seven students who completed the Student Preparation and Intent Questionnaire and the Course Achievement Test, used as both a pretest and a posttest, were included in the statistical analyses presented in this study. A Course Evaluation Questionnaire was developed to survey student opinion related to the methods used in the course and the situations in which these methods were used.

The development and implementation of the course materials were presented in Chapter III. The hypotheses presented in Chapter I are related to an evaluation of st

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student preparation for and achievement in the course. Student opinions were used to evaluate the course program as presented during the winter term, 1969. This chapter contains a description of the evaluative instruments used in the study. The administration of the instruments and the collection and treatment of the data are also described in the chapter.

The Course Achievement Test. A course examination was prepared to measure student achievement on the subject matter materials and experiences presented for the biology course. The Course Achievement Test contained one hundred, five foil, multiple choice items. These items were selected from a test file of items which had been collected or prepared by the writer and used during previous terms to test achievement in the course. Item analysis data on the test questions were used in the selection of the final items. Forty items were selected as an achievement measure for the three required content packages and twenty items were selected for each of the three optional packages. The items chosen for the Course Achievement Test had been selected for testing purposes by the senior staff members in previous terms and each subtest constructed was judged by them to have curricular validity. The one hundred item Course Achievement Test is shown in Appendix B.

Twenty-three of the items on the completed examination instrument were derived from Biological Science Curriculum

Study experimental test materials.[1,2,3] Eighteen were items or modifications of items found in the CUEBS[4] Report of the Panel on Evaluation and Testing.[5] The remaining 45 new test items were prepared by the investigator. Kuder Richardson 20 estimates of test reliability and indices of discrimination and difficulty for the subtests and the total test are shown in Table VIII. These data were obtained from the Michigan State University Office of Evaluation Services through the use of the IBM 1230 Optical Scanner and IBM 534 Card Punch and processed on the Control Data 360 Computer.

The one hundred item Course Achievement Test was administered to all students enrolled in the course as a pretest examination. The longest amount of consecutive time available in any scheduled class meeting was fifty minutes. The total test was conveniently divided into two parts and given during two separate time blocks. The first forty pretest items covering content Packages I, II, and III were

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[1]Biological Sciences Curriculum Study. Test Booklet for High School Biology. Boulder, Colorado: BSCS, 1966.

[2]Biological Sciences Curriculum Study. Test Booklet for an Inquiry into Life. Boulder, Colorado: BSCS, 1966.

[3]Biological Sciences Curriculum Study. Test Booklet for Molecules to Man. Boulder, Colorado: BSCS, 1966.

[4]CUEBS is used to designate the Commission on Undergraduate Education in the Biological Sciences.

[5]Commission on Undergraduate Education in the Biological Sciences. Testing and Evaluation in the Biological Sciences. A report of the panel on evaluation and testing. CUEBS publication # 20. Washington, D.C.: CUEBS, November 1967.

Table VIII. Reliability, indices of item discrimination and difficulty of Course Achievement Test.

	Number of Test Items	Pretest or Posttest	K.R. 20 Relia-bility	Index of Discrimi-nation[a]	Index of Diffi-culty[b]
Required Packages (1,2, and 3)	40	Pretest	.5666	27	59
		Posttest	.5161	23	40
Optional Package 4	20	Pretest	.3145	29	65
		Posttest	.7368	46	46
Optional Package 5	20	Pretest	.3462	29	52
		Posttest	.6029	35	39
Optional Package 6	20	Pretest	.4097	31	66
		Posttest	.6590	41	45
Total Test (1-6)	100	Pretest	.7310	21	60
		Posttest	.8381	26	42

[a]Difference between the percentage of the upper 27% of the class marking the right answer and the percentage of the lower 27% of the class marking the right answer.

[b]Percentage of the total group marking a wrong answer or omitting the item.

administered during the large assembly session held January 6, 1969, the first class day of the winter term. The students were told that the pretest data would be useful to the staff in evaluating average student achievement in the course program. They were encouraged to respond to each item and told that the scores would not be used for grading purposes. The remaining sixty pretest items based on Packages IV, V, and VI were administered to the students at their respective recitation and response sessions held during the second week of the term. The same test instructions given at the initial session were repeated at these sessions.

One hundred thirty-four students took the first part of the pretest at the initial large assembly session. The class roster was checked to determine which students were enrolled in the course, but were absent for the first session of the course. Individual appointments with these students to complete the examination were arranged by telephone. Within two days complete pretest data had been obtained for one hundred forty-five students enrolled in the course. Data for all the students in the class on the second part of the test were obtained at recitation and response sessions held during the second week of the term.

Scoring of the student responses to the test items was accomplished on the IBM 1230 Optical Scanner at the Michigan State University Scoring Office. The raw pretest scores on the Course Achievement Test were recorded from the examination answer sheets onto data sheets. The raw scores were listed by student and categorized by the high school preparation in biology the student had received. The students were placed into one of seven categories on the basis of biographical data they had supplied. The categories were: (1) no biology preparation, (2) BSCS Blue Biology, (3) BSCS Green Biology, (4) BSCS Yellow Biology, (5) one year of some other biology, (6) more than one year of biology including BSCS Biology, (7) more than one year of biology not including BSCS Biology. A one-way analysis of variance on the pretest examination scores used the raw scores grouped by student preparation in high school biology. The F statistic described by Hays[6] was used to test for a significant difference between the examination scores achieved by students in the seven biology preparation categories. The F value obtained was checked for significance in Guenther.[7]

The Course Achievement Test was also presented as the final examination in the course. The students were given instructions to respond to those items of the examination indicated for the content packages they had selected for their course program. To obtain posttest data for this research study the students were asked to respond to all of

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[6]William L. Hays. Statistics for Psychologists. New York: Holt, Rinehart and Winston, 1963. p. 369.

[7]William C. Guenther. Analysis of Variance. Englewood Cliffs, New Jersey: Prentice-Hall, 1964. pp. 172-83.

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the remaining items before turning in the examination materials. They were told that the responses they made to questions covering content areas which they had not selected as a part of their content program would not be used for grading purposes. Scoring of the Course Achievement Posttest was accomplished on the 1230 Optical Scanner at the Michigan State University Scoring Office.

The raw posttest achievement scores were recorded on data sheets from examination answer sheets. Student selection of the optional content package materials facilitated the designation of six content sequence groups. The content sequences involved included packages: (1) I, II, III, and IV, (2) I, II, III, and V, (3) I, II, III, and VI, (4) I, II, III, IV, and V, (5) I, II, III, V, and VI, (6) I, II, III, IV, V, and VI. The raw posttest achievement scores were recorded by student and categorized by the content sequence the students had selected for the term. A one-way analysis of variance technique used student raw scores grouped by the content sequence selected. The F statistic was used to test for a significant difference between the examination scores achieved by the students in the six content sequence categories. The F value obtained was checked for significance in Guenther.[8] Since the F value obtained showed overall significance, the data were explored to find the source

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[8]*Ibid*.

of the difference which existed. A significant F test can be interpreted as evidence that among all possible comparison values at least one true comparison value is not zero.[9] The Scheffe method described in Hays[10] was used to evaluate the comparisons among the means and grouped means of the six content sequence groups to locate the sources of the difference existing in the data.

The posttest achievement scores of the six content sequence groups were also recorded separately for the required content packages and each of the optional content packages. The analysis of variance technique was used in each case to analyze the variances of the groups and provide a measure of any difference between those sequence groups which had included the specific package or packages in their content selection and those groups that had not included the specific package or packages.

The raw achievement posttest scores were also tabulated on data sheets and categorized by sex. A t test statistic described by Weinberg and Schumaker[11] was used to test for a significant difference between the mean achievement posttest scores of the sexes. The t value produced was checked for significance in Hays.[12]

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[9]Hays, op. cit., p. 485. [10]Ibid., pp. 483-87.

[11]George E. Weinberg and John A. Schumaker. Statistics: An Intuitive Approach. Belmont, California: Wadsworth Publishing Company, 1962. pp. 199-203.

[12]Hays, op. cit., p. 674.

The amount of time students indicated they spent in the individual study session, to the nearest quarter hour, was recorded on data sheets. The time figures were taken from time cards kept in the study center and filled in by the students at the time of each visit. The time was tabulated for the three required packages and for each of the three optional packages. The amounts of time listed for the required packages were recorded for those students who responded to all of the question areas on the achievement posttest. The amounts of time for each of the optional packages were recorded only for those students who completed the package and also answered the questions for all of the question areas on the posttest instrument. The Pearson product-moment correlation formula presented by Weinberg and Schumaker,[13] was used to calculate a correlation coefficient between time spent and raw posttest score achieved for the required packages and each of the optional packages. A z conversion described by Weinberg and Schumaker[14] was used to transform the correlation coefficient into a z value. The z value obtained is representative of the computed correlation coefficient and can be located in the normal distribution of z scores to determine significance. The z value produced was checked for significance in Weinberg and Schumaker.[15]

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[13]Weinberg and Schumaker, op. cit., p. 264.

[14]Ibid., pp. 287-89.

[15]Ibid., p. 320.

Separate listings of the raw achievement pretest and posttest scores were also made by student for each of the optional content packages and the required content packages. Mean gain scores were calculated for each optional package based on the scores of the students selecting the specific content. The mean gain score was also found for the required packages of the course which was completed by all the students included in the sample.

The Student Preparation and Intent Questionnaire. A series of questionnaire items was constructed by the author during the fall term, 1968, to collect biographical information from the students who would be enrolled in Lyman Briggs College Biology 140 during the winter term, 1968. This questionnaire was revised after it was used in that winter term. The questionnaire was also revised following use during the spring and fall terms, 1968. The third revision of the questionnaire was presented to the student population enrolled during the winter term, 1969, the term in which this research study was conducted.

The students were asked to fill in the required responses to the questionnaire items during their first visit of the term at the individual study center. Of major interest to this study were those items related to the kind and number of biology courses the students had taken in high school. This information was used to categorize the student population for the one-way analysis of variance using the course pretest achievement and high school preparation in biology reported earlier in this chapter. Since student opinions were used to evaluate the course program, the factors students noted as producing individual concern or self-confidence about the course they were beginning were also of special interest. The Student Preparation and Intent Questionnaire is shown in Appendix A.

The Course Evaluation Questionnaire. The Course Evaluation Questionnaire was developed by the author to survey student opinion related to the biology course with which this study is concerned. Similar evaluation questionnaires had been presented to all students completing the course during the time before the winter term, 1969, in which this study was completed. The form used during this term resulted from the revisions of these earlier instruments. The Course Evaluation Questionnaire contained one hundred and one positive statements placed within the context of four broad course categories. The students were asked to mark answers to designate: (1) strongly agree, (2) agree, (3) no basis for an opinion, (4) disagree, or (5) strongly disagree, for each statement. The questionnaire items are listed in Appendix C.

The Course Evaluation Questionnaire was given to students at the last large assembly session of the winter term, 1969. Questionnaires with the necessary instructions attached were placed in the mail boxes of all students who were not present at this final session of the term. One hundred forty-two students returned response sheets at the time of the scheduled final examination as requested. This was a 97.9 per cent return for the response sheets. The course evaluation responses were anonymous. Since this was the case, all students who completed responses are included in the reported results. A tabulation of the student responses to the evaluation questionnaire items was completed with the IBM 1230 Optical Scanner and IBM 534 Card Punch and processed by the IBM 1401 Computer.

Grading procedure for Lyman Briggs College Biology 140. Final grades given in Lyman Briggs College Biology 140 were based on the total raw score points any student had achieved in the given term. These total raw scores were converted to percentages and numerical grades assigned on a 0-4.5 grade scale. For the three credit course there were one hundred and fifty possible points. These points were achieved on a midterm examination for Packages I, II, and III (fifty points), final examination questions on Packages I, II, and III (forty points), a recitation and response evaluation for Packages I, II, and III (thirty points), the final examination on the required additional package (twenty points), and a recitation and response evaluation from the additional package (ten points). The raw scores achieved on the package selected as a part of the three credit course minimum were added directly to the scores received on the required packages and a grade distribution constructed.

Grade distributions for the optional packages were arrived at individually and all scores achieved in a specific package were used to construct the grade distributions. Separate grades were given for the extra packages taken and credit listed under a Special Problems title, Lyman Briggs College 290.

<u>Summary</u>. During the winter term, 1969, Lyman Briggs College Biology 140, as described in Chapter III, was examined. The examination included an evaluation of student achievement in the course as evidenced by course achievement pretest and posttest scores and student opinions of the course collected on a Course Evaluation Questionnaire response sheet.

All of the students enrolled in the course completed the Course Achievement Pretest and a Student Preparation and Intent Questionnaire. Students were included in the statistical analyses of the raw scores collected during the study if they also completed all of the parts of the Course Achievement Posttest. The student raw scores were grouped by high school preparation in biology, content sequence elected for the course, and sex and were analyzed with the one-way analysis of variance and t test techniques. Time spent in the individual study session was correlated with raw posttest achievement scores and the coefficient transformed into a z value to check whether the correlation coefficient represented by the z value was significant.

Gain scores were reported for the required and optional packages of the course. Final grades were also recorded for presentation with the data.

CHAPTER V

ANALYSIS OF DATA AND RESULTS

An analysis of the data collected on the student population enrolled in Lyman Briggs College Biology 140 during the winter term, 1969, is presented in this chapter. The hypotheses and models used to test these hypotheses, as well as the analysis of the data relevant to the hypotheses, are included in the chapter. The data retrieved from the Student Preparation and Intent Questionnaire to reflect initial student feeling about an audio-tutorial course are listed. The findings of the Course Evaluation Questionnaire are also reported in the chapter.

Hypotheses and models used to test the hypotheses. Pretest scores, posttest scores, and individual study session time data for the winter term, 1969, student population of Lyman Briggs College Biology 140 were compiled for statistical analysis. The research hypotheses formulated for the study and the null hypothesis used for testing each were as follows:

Hypothesis One: Students who have had BSCS Biology in high school have higher pretest scores on a test designed for a college biology course than students who have not had a BSCS Biology course in high school.

H_{0_1}: $BP_1 = BP_2 = BP_3 = BP_4 = BP_5 = BP_6 = BP_7$

(BP indicates a group of students within the population categorized by kind of biology preparation in high school.)

Hypothesis Two: Students who have had more high school preparation in biology have higher pretest scores on a test designed for a college biology course than students who have had less high school preparation in biology.

H_{0_2}: $BP_1 = BP_2 = BP_3 = BP_4 = BP_5 = BP_6 = BP_7$

(BP indicates a group of students within the population categorized by number of biology courses taken in high school.)

Hypothesis Three: Students who select more content in a variable content—variable credit college biology course have higher posttest scores on a test for the college course than those students who select less content.

H_{0_3}: $CS_1 = CS_2 = CS_3 = CS_4 = CS_5 = CS_6$

(CS indicates a group of students within the population categorized by the content sequence selected for the course.)

Hypothesis Four: Male students receive higher posttest scores on a test designed for a college biology course than female students receive on the posttest.

H_{0_4}: $S_1 = S_2$

(S indicates a group of students within the population categorized by sex.)

Hypothesis Five: Students who spend more time in individual study sessions on the content materials presented in a college biology course receive higher posttest scores on tests for the college course than students who spend less time in individual study sessions.

H_{0_5}: $TP_c = 0$

(TP_c indicates the correlation coefficient for the correlation between time spent in the individual study session and posttest achievement score.)

Analysis of the data relevant to hypotheses one and two--Student preparation in high school biology. Course achievement pretest data for the student population was organized into seven groups based on high school preparation in biology. These groups included students in the population who had high school programs which included: (1) no biology (BP_1), (2) BSCS[1] Blue Biology (BP_2), (3) BSCS Green Biology (BP_3), (4) BSCS Yellow Biology (BP_4), (5) one year of biology other than BSCS Biology (BP_5), (6) more than one year of biology including BSCS Biology (BP_6), and (7) more than one year of biology other than BSCS Biology (BP_7). The one-way analysis of variance technique was employed to test for a significant difference between pretest examination scores for the students grouped by high school preparation in biology. Table IX summarizes the results of the analysis of variance procedure used to test the hypotheses ($H_{0,1\&2}$: $BP_1=BP_2= \ldots =BP_7$). Based on the statistical

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[1]BSCS is used to designate the Biological Sciences Curriculum Study.

Table IX. One-way analysis of variance for the pretest scores of the winter, 1969, student population based on high school preparation in biology.

High School Preparation	N_i	ΣX_i	$\frac{\Sigma X_i}{N_i}$	ΣX_i^2	$\frac{(\Sigma X_i)^2}{N_i}$	$\frac{(\Sigma\Sigma X_{Total})^2}{N_{Total}}$
No Biology (BP_1)	3	108	36.00	3,920	3,888	
BSCS Blue Biology (BP_2)	11	419	38.09	16,255	15,960.09	
BSCS Green Biology (BP_3)	12	523	43.58	23,143	22,794.08	
BSCS Yellow Biology (BP_4)	18	637	35.39	23,473	22,542.72	
One Year Other Biology (BP_5)	54	2167	40.13	90,897	86,960.91	
More than One Year Biology Including BSCS (BP_6)	28	1130	40.36	47,928	45,603.57	
More than One Year Other Biology (BP_7)	11	489	44.45	22,801	21,738.27	
	N_{Total} = 137	$\Sigma\Sigma X_{Total}$ = 5,473		$\Sigma\Sigma X^2_{Total}$ = 228,417	$\Sigma\frac{(\Sigma X)^2}{N_i}$ = 219,487.64	$\frac{(\Sigma\Sigma X)^2}{N_{Total}}$ = 218,640.36

One-way Analysis of Variance Formula

Source	SS	df	MS	F
Between	$\Sigma\frac{(\Sigma X)^2}{N_i} - \frac{(\Sigma\Sigma X)^2}{N_{Total}}$	K-1	$\frac{SS_{between}}{K-1}$	$\frac{MS_{between}}{MS_{within}}$
Within	$\Sigma\Sigma X^2 - \frac{\Sigma(\Sigma X)^2}{N_i}$	N-K	$\frac{SS_{within}}{N-K}$	
Total	$\Sigma\Sigma X^2 - \frac{(\Sigma\Sigma X)^2}{N_{Total}}$	N-1		

One-way Analysis of Variance Summary Table

Source	SS	df	MS	F[a]
Between	847.28	6	141.21	2.06 NS[b]
Within	8,929.36	130	68.69	
Total	9,776.64	136		

[a]Checked in: William C. Guenther. Analysis of Variance. Englewood Cliffs, New Jersey: Prentice-Hall, 1964. pp. 172-83.

[b]Not significant at 0.05. Tabled $F^{0.05}_{(6, \infty)}$ value is 2.10.

evidence, the null hypotheses stating that there were no differences in the pretest achievement scores of the student groups, categorized by high school preparation in biology, was not rejected. No significant difference was found between the seven categories of student preparation in high school biology based on course pretest scores. Since no significant difference existed between the seven categories at the 0.05 level, one may conclude there was no significant difference between any two categories or between combinations of these categories at or beyond that level.[2] This finding would indicate that no significant difference was apparent for course pretest achievement based on the kind of high school biology (BSCS Blue Biology, BSCS Green Biology, BSCS Yellow Biology, biology other than BSCS Biology, or a combination of BSCS Biology and other biology) or number of high school biology courses (no biology, one year of biology, more than one year of biology). One can conclude from these findings that there is no significant advantage or disadvantage for student achievement in Lyman Briggs College Biology 140 based on the kind or number of biology courses students had taken in high school.

Analysis of the data relevant to hypothesis three--Content sequence selected for Lyman Briggs College Biology 140. Posttest data for the student population was organized with respect to six possible course content sequences.

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[2]William L. Hays. Statistics for Psychologists. New York: Holt, Rinehart and Winston, 1963. p. 485.

The course content sequences which were selected by the six student groups in the population were as follows: (1) Packages I, II, III, and IV, (2) Packages I, II, III, and V, (3) Packages I, II, III, and VI, (4) Packages I, II, III, IV, and V, (5) Packages I, II, III, V, and VI, or (6) Packages I, II, III, IV, V, and VI. The mean posttest scores for the content package sequence groups are shown in Table X. The one-way analysis of variance technique was employed to analyze posttest examination scores for the students grouped by the course content sequence they had completed. Table XI (p. 90) summarizes the results of the analysis of variance procedure used to test the hypotheses ($H_{0,3}$: $CS_1 = CS_2 = \ldots = CS_6$). The null hypothesis was rejected at the 0.001 level of significance. This indicates that a significant difference existed between the content sequence groups as evidenced by their course posttest scores. Since overall significance was indicated by the data, the Scheffe method of evaluating comparisons among the content sequence groups was used to find the sources of the difference existing in the data. The pair-wise differences between the content sequence groups means are shown in Table XII (p. 92). A sample of the calculation technique used to test each of the contrasts is shown in Table XIII (p. 93). Only two of the differences between the group means were sufficiently large for significance to be illustrated at the 0.05 level. The two significant contrasts were between content sequences

Table X. Mean posttest scores for the content sequence groups.

Content Sequence	Designations for Sequence Group Mean	Mean Posttest Score	Number of Individuals in Sequence Group
I,II,III,IV,V	μ_4	64.38	8
I,II,III,IV,V,VI	μ_6	60.65	93
I,II,III,IV	μ_1	55.50	8
I,II,III,VI	μ_3	50.73	11
I,II,III,V,VI	μ_5	49.80	5
I,II,III,V	μ_2	47.08	12

Table XI. One-way analysis of variance for the posttest scores of the winter term, 1969, student population based on content sequence selected.

Package Content Selected	N_i	ΣX_i	$\frac{\Sigma X_i}{N_i}$	ΣX_i^2	$\frac{(\Sigma X_i)^2}{N_i}$	$\frac{(\Sigma\Sigma X_{Total})^2}{N_{Total}}$
1,2,3, and 4 (CS_1)	8	444	55.50	25,220	24,642.00	
1,2,3, and 5 (CS_2)	12	565	47.08	27,451	26,602.08	
1,2,3, and 6 (CS_3)	11	558	50.73	29,696	28,305.82	
1,2,4, and 5 (CS_4)	8	515	64.38	33,533	33,153.13	
1,2,3,5, and 6 (CS_5)	5	249	49.80	12,479	12,400.20	
1,2,3,4,5, and 6 (CS_6)	93	5640	60.65	350,728	342,038.71	
	$N_{Total} =$ 137	$\Sigma\Sigma X_{Total} =$ 7,971		$\Sigma\Sigma X^2_{Total} =$ 479,107	$\frac{\Sigma(\Sigma X)^2}{N_i} =$ 467,141.94	$\frac{(\Sigma\Sigma X)^2}{N_{Total}} =$ 463,772.56

One-way Analysis of Variance Formula

Source	SS	df	MS	F
Between	$\Sigma\frac{(\Sigma X)^2}{N_i} - \frac{(\Sigma\Sigma X)^2}{N_{Total}}$	K-1	$\frac{SS_{between}}{K-1}$	$\frac{MS_{between}}{MS_{within}}$
Within	$\Sigma\Sigma X^2 - \frac{\Sigma(\Sigma X)^2}{N_i}$	N-K	$\frac{SS_{within}}{N-K}$	
Total	$\Sigma\Sigma X^2 - \frac{(\Sigma\Sigma X)^2}{N_{Total}}$	N-1		

One-way Analysis of Variance Summary Table

Source	SS	df	MS	F[a]
Between	3,369.38	5	673.88	7.38 S[b]
Within	11,965.06	131	91.34	
Total	15,334.44	136		

[a]Checked in William C. Guenther. Analysis of Variance, Englewood Cliffs, New Jersey: Prentice-Hall, 1964. pp. 172-83.

[b]Significant beyond 0.001. Tabled $F^{0.001}_{(5, \infty)}$ value is 4.10.

Table XII. Pair-wise differences for the contrasts involving posttest means for content sequence groups.

Content Sequence Group		Packages 1,2,3, and 5 (μ_2)	Packages 1,2,3, and 6 (μ_3)	Packages 1,2,3,4, and 5 (μ_4)	Packages 1,2,3,5, and 6 (μ_5)	Packages 1,2,3,4,5, and 6 (μ_6)
	Posttest Mean	47.08	50.73	64.38	49.80	60.65
Packages 1,2,3, and 4 (μ_1)	55.50	-8.42	-4.77	8.88	-5.70	5.15
Packages 1,2,3, and 5 (μ_2)	47.08		3.65	17.30 S[a]	2.72	13.57 S[a]
Packages 1,2,3, and 6 (μ_3)	50.73			13.65	-0.93	9.92
Packages 1,2,3,4, and 5 (μ_4)	64.38				-14.58	-3.73
Packages 1,2,3,5, and 6 (μ_5)	49.80					10.85

[a]Significant contrast at 0.05.

Table XIII. Sample Scheffe[a] calculation to locate significant contrasts between posttest means of content sequence groups.

$$\hat{\psi} = \mu_2 - \mu_1 \pm \sqrt{S^2 \, MS_w \, \omega_g}$$

Where: $\hat{\psi}$ is the value of a particular comparison among group means.

μ_2 and μ_1 are group means.

$S^2 = (K-1)\ (F^{0.05}_{K-1,\ N-K})$.

MS_w is the mean square within value.

ω_g is the weighting factor for sum of squares in the comparison.

$$\hat{\psi} = -8.42 \pm \sqrt{(5)(2.21)(91.336)(\tfrac{1}{8} + \tfrac{1}{12})}$$

$$\hat{\psi} = -8.42 \pm \sqrt{(11.05)\ (91.336)\ (.2083)}$$

$$\hat{\psi} = -8.42 \pm \sqrt{210.23}$$

$$\hat{\psi} = -8.42 \pm 14.5 \quad \text{NS}^{b}$$

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[a]From: William L. Hays. Statistics for Psychologists. New York: Holt, Rinehart and Winston, 1963. pp. 483-87.

[b]Not significant at 0.05. The interval crosses zero. The obtained difference between group means of -8.42 is not greater than 14.5 in absolute magnitude.

I, II, III, IV, and V and I, II, III, IV, V, and VI with means significantly different from the I, II, III, and V content sequence mean. Contrasts were also made for the means of the content groups involving the amount of course content selected. These contrasts involved those groups selecting four, five, or six packages of course content. The contrasts and differences are shown in Table XIV. Only the difference between the means of the four and six package content sequence groups was large enough to be significant at the 0.05 level. From the above the inference may be made that, although only the posttest scores of those students taking four or six packages were significantly different, students taking more content tended to have higher posttest scores.

The contribution of the optional content Packages V and VI toward the course posttest scores appeared to be somewhat less than that of the optional content package IV. To provide a check on these results the posttest achievement scores of the content sequence groups for the required content packages and each of the optional content packages were analyzed. A summary of a one-way analysis of variance of the package scores categorized by content sequence group is presented in Table XV (p. 96). The posttest achievement levels for the sequence groups on the required packages were not significantly different at the 0.05 level. The posttest achievement levels for the sequence groups on each of the optional content packages was significant at the 0.001 level.

Table XIV. Pair-wise differences for the contrasts involving pooled posttest means for combined content sequence groups.

Pooled Groups		1,2,3,4,and 5 1,2,3,5,and 6 ($\mu_4 + \mu_5$)	1,2,3,4,5,and 6 (μ_6)
	Posttest Mean	57.09	60.65
1,2,3,and 4 1,2,3,and 5 1,2,3,and 6 ($\mu_1+\mu_2+\mu_3$)	51.10	-5.99	-9.62 S[a]
1,2,3,4,and 5 1,2,3,5,and 6 ($\mu_4 + \mu_5$)	57.09		-3.56

[a]Significant contrast at 0.05.

Table XV. One-way analysis of variance results on the post-test scores of the required and optional packages for the content sequence groups.

	F^a obtained
Posttest scores of content sequence groups on I, II, III	1.69 NS[b]
Posttest scores of content sequence groups on optional Package IV	21.32 S[c]
Posttest scores of content sequence groups on optional Package V	6.2 S[c]
Posttest scores of content sequence groups on optional Package VI	6.70 S[c]

[a]Checked in William C. Guenther. Analysis of Variance. Englewood Cliffs, New Jersey: Prentice-Hall, 1964. pp. 172-83.

[b]Not significant at 0.05. Tabled $F^{0.05}_{(5, \infty)}$ value is 2.21.

[c]Significant beyond 0.001. Tabled $F^{0.001}_{(5, \infty)}$ value is 4.10.

This would indicate that the course achievement posttest scores for the content sequence groups varied due to the presence or absence of specific optional packages and were not the result of a significant difference between the achievement of the content sequence groups on the required content packages included in the course format of each content sequence. The F value obtained from the analysis of variance of the posttest scores of the content sequence groups on optional content Package IV was much larger than that obtained on either Package V or Package VI. From these results it can be inferred that a student selecting Package IV, as the only optional package or in combination with other optional packages, might have had the best opportunity to achieve a high posttest score.

Analysis of the data relevant to hypothesis four--Sex and student achievement. Posttest data for the student population was organized with respect to a student's sex. The t test was used to test for a significant difference between the course posttest means of the male and female students. The t value of 0.59 produced was checked in Hays[2] for significance. The hypothesis ($H_{0,4}$:S_1=S_2) failed to be rejected at the 0.05 significance level. These results indicate that no significant difference existed between the male and female groups based on course posttest scores.

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[2]Hays, op. cit., p. 674. Tabled $t^{0.05}_{(\infty)}$ value is 1.645.

The conclusion can be made that no significant advantage or disadvantage was apparent for student posttest achievement on the basis of the male and female groups tested.

Analysis of the data relevant to hypothesis five--Relationship between time spent in individual study sessions and course achievement scores. The amount of time the students in the population spent in the individual study session, to the nearest quarter hour, was correlated with the posttest scores the students received on specific parts of the course. The Pearson product-moment formula was used to obtain the correlation coefficient between time spent and posttest scores achieved. These data are presented in Table XVI. The hypothesis ($H_{0,5}$:TP_c=0) failed to be rejected for the required content packages and optional Packages V and VI. The hypothesis was rejected for content Package IV. These results indicate that only the correlation coefficient obtained between time spent in the individual study session and posttest achievement scores for Package IV was sufficiently far from zero to produce a significant positive relationship. The inference can be made that on Package IV an increase in time spent in the individual study session would result in increased achievement as evidenced by higher posttest achievement scores.

Gain scores and final grades. Gain scores for the students completing the required packages of the course and each of the optional packages and related data are presented

Table XVI. Pearson product-moment correlation coefficients on time and posttest scores for required course content packages and optional course content packages.

Packages	Number of Individuals Completing Designated Content	Correlation Coefficient	z[a]
I,II,III	137	.1124	1.31 NS[b]
IV	109	.2145	2.23 S[c]
V	118	.0309	0.33 NS[b]
VI	109	.1261	1.31 NS[b]

[a]Checked in: George H. Weinberg and John A. Schumaker. Statistics: An Intuitive Approach. Belmont, California: Wadsworth Publishing Company, 1962. p. 320.

[b]Not significant at 0.05.

[c]Significant at 0.05.

in Table XVII. The per cent raw score gains for content Packages I, II, and III and content Package V are somewhat below that of the other content packages. This can be expected when the pretest means are somewhat higher.[3] Final Grades given during the winter term, 1969, are presented in Table XVIII (p. 102).

<u>Student Preparation and Intent Questionnaire--Student comments</u>. Before the students had actually started their individual study work, they were asked on a Student Preparation and Intent Questionnaire to note their initial concern and/or feeling of confidence in anticipation of the audio-tutorial program. A compilation of the types of student concern and the actual frequencies of those types which were reported by ten or more students is as follows:

1. Lack of individual discipline; tendency to procrastinate; indolence generated in an independent, flexible course when planning is required for necessary study time. (43)

2. Poor academic background in biology; poor high school course; non-recency of contact with biological science materials. (24)

3. Unfamiliarity with course organization, methods and requirements. (18)

4. Fear of having to give oral responses in rigid recitation and response sessions without an appropriate indication of achievement. (13)

5. Early "jitters" regarding tests, grades, and animal dissection. (11)

6. Lack of motivation. (10)

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[3]Personal conversation with Dr. Clarence H. Nelson, Evaluation Services, Michigan State University.

Table XVII. Gain score information for student population completing designated parts of the course program.

Content Packages	Number of Pretest Posttest Items	Number of Individuals Completing Designated Content	Raw Pretest Score Mean	Raw Posttest Score Mean	Mean Gain in Raw Score	Per cent Raw Score Gain
1,2,3	40	137	16.35	24.12	7.77	19.47
4	20	109	7.02	11.92	4.90	24.49
5	20	118	9.70	12.77	3.07	15.35
6	20	109	7.07	11.74	4.67	23.34

Table XVIII. Final grades given in Lyman Briggs Biology 140 during winter term, 1969.

	4.0	3.5	3.0	2.5	2.0	1.5	1.0	Totals
Package 4	18	31	50	9	0	1	0	109
Package 5	17	32	54	13	0	2	0	118
Package 6	17	28	48	15	0	1	0	109
Packages 1,2,3 and 1 other package for 3 hours credit	19	12	40	36	20	9	1	137

[a]Based on a 0-4.5 grade scale. The 4.5 grade, when given is applicable to a very exceptional achievement.

An initial feeling of student confidence or assurance was noted in the following questionnaire responses:

1. Interest in biology. (36)
2. Biology background. (37)
3. Can benefit from independent study. (17)
4. High school record. (16)

Course Evaluation Questionnaire--Student responses. The percentage of students marking the response categories for the Course Evaluation Questionnaire is shown in Appendix C. The categories strongly agree and agree and disagree and strongly disagree were tabulated as agree and disagree, respectively. Those items in which the student responses held significance, in the opinion of the investigator, are noted in Tables XIX-XXII (pp. 104-110). The implications presented in Chapter VI considered these student responses as well as other investigator contacts with students, student assistants, graduate assistants, and senior staff members.

Table XIX. Selected student responses on the total course program from the Course Evaluation Questionnaire results.[a]

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
2	The course was not among the most intellectually satisfying college courses students had taken.	62
5	One of the course objectives was to teach general principles (generalizations).	82
6	One of the course objectives was to teach application skills.	58
10	One of the course objectives was to instill a desire for further learning.	54
12	It was difficult for students to get answers to questions in content areas where understanding was difficult.	53
13	Course instructors were readily available to help with student problems that required their personal attention.	47
19	The testing or evaluation procedure used in the course was not adequate for grading purposes.	66
20	The test scores did not adequately evaluate an understanding noted by the content objectives.	57
24	The course did make a contribution in the areas of biology studied.	73
25	The course did make a contribution to an intellectual interest in ecology.	54

continued

Table XIX--continued

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
26	The course did make a contribution to an awareness of ecological relationships.	84
31	Students desire more help in choosing which packages they should take.	43
32	At the beginning of the program students liked the idea of being able to take an audio-tutorial course.	71
33	At the close of the course students liked the experience of having taken an audio-tutorial course.	56

[a]Complete results are shown in Appendix G.

Table XX. Selected student responses on the large assembly session from the Course Evaluation Questionnaire results.[a]

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
35	The large assembly session helped to increase student interest in the course.	52
37	The large assembly session helped to make the course intellectually stimulating.	50
39	Guest speakers discussed subject areas relative to the course.	66
40	Films presented subject matter material not used in the individual study session.	49
41	Films presented subject matter material later used in the individual study session.	56
46	Test scores received on the midterm were not indicative of an understanding of course materials.	66
47	Midterm test did not illustrate an adequate content sample for grading purposes.	63

[a]Complete results are shown in Appendix G.

Table XXI. Selected student responses on the individual study session from the Course Evaluation Questionnaire results.[a]

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
48	Individual study sessions are intellectually more rewarding than college classroom lectures.	47
49	Individual study sessions enable students to make more efficient use of study time.	49
54	Individual study sessions made a contribution toward comprehension in the areas of biology studied.	70
55	Individual study sessions made a contribution toward an intellectual interest in ecology.	53
56	Individual study sessions made a contribution toward student awareness of ecological relationships.	69
58	Noise and distraction did not hinder effective study in the individual study session.	71
59	Study materials were readily available for student use.	63
60	Content package objectives were clearly pointed out.	77
61	Study materials emphasized relationships rather than minute' detail.	58
65	As a result of the study program students can work easily with a microscope.	68

continued

Table XXI--continued

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
66	Adequate instruction was given for proper use of the study carrel.	72
67	Study programs are sufficient to guide students through the experiences provided.	56
69	I completed less than fifty per cent of the individual study session activities presented outside the carrel.	30
70	I completed more than seventy-five per cent of the individual study session activities presented outside the carrel.	47
71	Activities presented outside the study carrel were not essential for content package understanding.	62
72	More "do-it-yourself" projects should be provided for maximum program effectiveness.	22
73	Slide sequences are a necessary part of the session.	72
75	Study guides and outlines are useful in helping students to organize the materials presented.	80
76	Study guides should have more informative content and fewer questions.	64
77	For every hour spent in the individual study session, I spent less than 1½ hours in other course study.	60
78	For every hour spent in the individual study session, I spent between 1½ and 3 hours in other course study.	26

continued

Table XXI--continued

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
79	For every hour spent in the individual study session, I spent 3 hours or more in other course study.	10
83	Students found study carrels unavailable when they wanted one.	54
84	An insufficient number of study carrels prevented my weekly use of the prepared materials.	19

[a]Complete results are shown in Appendix G.

Table XXII. Selected student responses on the recitation and response session from the Course Evaluation Questionnaire results.[a]

Questionnaire Item Number Reference	Student Opinion	Percentage of Population Having Opinion
87	Recitation and response sessions facilitated an expression of individual achievement.	51
88	Students did most of the talking in the session.	66
92	Participation in the session contributed to a comprehension in the areas of biology studied.	66
94	Participation in the session contributed toward an awareness of ecological relationships.	58
95	Study guides were more effective than the course text or other references in preparing for the recitation and response session.	56
96	The appropriateness of participation in the session was directly related to the amount of time spent on the content packages.	51
97	The quality of student responses were directly related to an understanding of the materials.	58

[a]Complete results are shown in Appendix G.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to examine an experimental, beginning biology course in Lyman Briggs College at Michigan State University. The course was organized as a variable content-variable credit program and presented by means of an audio-tutorial approach. The evaluation of the course consisted of an appraisal of student achievement in the course and student reaction to and participation in the course.

Design of the study and treatment of data. The study involved one hundred thirty-seven college students enrolled in Lyman Briggs College Biology 140 during the winter term, 1969. These students completed a pre-course Student Preparation and Intent Questionnaire, took the Course Achievement Pretest and Posttest, and returned a Course Evaluation Questionnaire response sheet. The data retrieved included the nature of the student's preparation in high school biology and his pre-course feelings about the biology course, the raw score achievement illustrated on the course pretest and posttest, and post-course student reaction to their participation in the course program.

The course achievement pretest scores, based on the kind and number of high school biology courses the students had, were analyzed for significant differences with the one-way analysis of variance technique. The course achievement posttest scores, based on the student selected content package sequence were also analyzed with the one-way analysis of variance technique. The course achievement posttest scores, based on student sex, were analyzed with the t test. The 0.05 level of significance was selected as the minimum criterion against which all statistical results were checked. Results significant at this level were considered to have originated from other than chance events. Student opinions, represented by the responses given to selected items on the Course Evaluation Questionnaire, were used as basic data in assessing student reaction to the course.

Hypotheses tested. The hypotheses related to the examination of student achievement in the course studied were:

1. Students who have had BSCS Biology in high school have higher pretest scores on a test designed for a college biology course than students who have not had a BSCS Biology course in high school.

2. Students who have had more high school preparation in biology have higher pretest scores on a test designed for a college biology course than students who have had less high school preparation in biology.

3. Students who select more content in a variable content—variable credit college biology course have higher posttest scores on a test for the college course than those students who select less content.

4. Male students receive higher posttest scores on a test designed for a college biology course than female students receive on the posttest.

5. Students who spend more time in individual study sessions on the content materials presented in a college biology course receive higher posttest scores on tests for the college course than students who spend less time in individual study sessions.

Results and overall conclusions. Hypothesis One, which held that students who had BSCS Biology in high school would have higher pretest scores on a test designed for a college biology course than students who had not had a BSCS Biology course, was not supported by the data. Therefore, the conclusion can be drawn that the kind of high school biology a student had taken in high school did not offer a significant advantage or disadvantage for a student as preparation for Lyman Briggs College Biology 140.

Hypothesis Two, which held that students who had more biology courses in high school would have higher pretest scores on a test designed for a college biology course, was not supported by the data. Thus, the conclusion can be drawn that the number of high school courses in biology a student has had was not of significant advantage or disadvantage for a student as preparation for Lyman Briggs College Biology 140.

Hypothesis Three involved posttest examination scores for students grouped by their selected course content sequences. The hypothesis held that those students who selected more content in Lyman Briggs College Biology 140 would have higher posttest scores than those students who selected less content. The data supported this hypothesis. Significant differences were found between those students who selected Packages I, II, III, and V and those who selected either Packages I, II, III, IV, and V or I, II, III, IV, V, and VI. In addition, the achievement of the student group that selected six content packages was significantly different from those who selected only four content packages. The content sequence groups did not differ in their posttest achievement scores on the required packages of the course. The sequence groups, as evidenced by posttest scores, were significantly different in their achievement on the optional packages. The inclusion or exclusion of Package IV in a content sequence produced greater significance than the inclusion or exclusion of either Package V or Package VI in a content sequence. That is, Package IV when used as a part of a four package content sequence or in combination with other optional packages increased the student's chances of achieving a higher posttest score. The conclusion can also be made that students who select more course content, evidenced by a selection of four, five, or six content packages, do tend to achieve higher posttest scores in the college course.

Academic achievement in Lyman Briggs College Biology 140 in relation to student sex was investigated by hypothesis Four. The hypothesis held that male students would achieve higher posttest scores on a test designed for Lyman Briggs College Biology 140 than the female students. The data failed to support the hypothesis. This would indicate that no significant advantage or disadvantage was apparent for the male and female groups tested for achievement in the college course.

Hypothesis Five held that students who spend more time in individual study sessions on the content materials would receive higher posttest scores on tests designed for the college biology course than students who spend less time. This hypothesis was separately tested for the required packages and each of the optional content packages. The data failed to support the hypothesis for the required packages (I, II and III), Package V, and Package VI. The data supported the hypothesis for Package IV. The conclusion can be made that only on Package IV were time spent in individual study sessions and posttest score significantly related. From these findings the inference may be drawn that on Package IV materials an increase in the time spent tended to result in an increase in the achievement score. These results tend to support the findings of Postlethwait, Novak, and Murray (101)[1] and Wash (102).

From a tabulation of student responses on the Student Preparation and Intent Questionnaire related to early

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[1]The numbers in parentheses refer to references cited in Chapter II.

student confidence and concern regarding the audio-tutorial course, several conclusions appear justified. Students at the beginning of the biology course appeared to base their individual feeling of confidence or lack of confidence on their strong or weak academic background in high school biology, respectively. It can also be concluded that while some students feel that they can benefit from an independent type study program other students have considerable concern originating in an individual tendency to procrastinate in making adequate study plans for such a course. The presence of an interest in biology was indicative of a feeling of early confidence about the course while the lack of motivation did produce a feeling of student concern. Student interest in biology may affect student performance in the course. Students who like a course may have distinct advantage, while the marks of those who do not suffer accordingly.

Student opinion, as evidenced by student responses on the Course Evaluation Questionnaire, in the opinion of the investigator, suggested the following conclusions related to the audio-tutorial program:

1. More students liked the idea of being able to take an audio-tutorial course than liked taking the course. These feelings are also in evidence when some students noted that the course was not among the most intellectually satisfying or stimulating college course they had taken.

2. The students generally believed that the college biology course did contribute to their awareness of ecological relationships, to an understanding

of the areas of biology studied, and to an intellectual interest in ecology.

3. The students generally felt the major course objectives were to teach general principles, application skills, and to instill a desire for further learning.

4. The students believed that the content objectives were clearly pointed out, but that the test scores generally were not indicative of student understanding of the course materials and that tests did not contain an adequate content sample suitable for grading purposes.

5. The students found the two-by-two slide sequences to be an essential program activity, but that those program activities presented outside the study carrel were not essential for an understanding of the content materials.

6. Some students felt that individual study sessions were not more rewarding than college classroom lectures, but did result in a somewhat more efficient use of study time.

7. The students generally found a carrel available for their use during each week of the term, but not always exactly when they wanted one.

8. The study guides appeared to be useful and sufficient as aids in organizing the content materials presented in the program. Some students would have appreciated more information in the study guides and fewer questions.

9. The student responses suggest a desire for more assistance with difficult subject matter content and materials especially in the individual study session.

10. The students felt that the recitation and response sessions allowed them to express individual achievement directly related to an understanding of the course content.

11. Students generally spent less than one and one-half hours of study effort outside of class for each hour spent in an individual study session.

Educational implications. In view of the findings of this study related to the data presented, the student opinions gathered, and personal contacts with the students, student assistants, graduate assistants, and senior staff members the following implications for audio-tutorial programs appear to be justified:

1. Materials used in audio-tutorial programs should be designed to specify what a student should be able to do following the completion of the content. Test items should be prepared to adequately sample the expected outcomes.

2. When a variable content-variable credit approach is used in an audio-tutorial course program, care should be taken not to duplicate educational experiences in the required and optional content areas of the course.

3. Course materials which have been developed to require manipulative skills or first hand discovery should be designed to provide for periodic checks on student progress and adequate instructor analysis of the final results.

4. For efficient and effective audio-tutorial instruction all persons connected with the instruction should be involved in the planning and set-up duties associated with the course program. These persons should also be fully acquainted with the laboratory equipment and supplies and be advised how to help students complete crucial phases of all programmed experiences.

5. An audio-tutorial course should be more than a program. Course content materials should be enhanced with topic lectures and films presented in large group sessions. Guest speakers should be used to supplement course content materials.

6. Students may be given the most help in planning their study of the content materials if a regular appraisal is made of their individual progress. Written and oral responses should be used to acquaint the students with the kinds of information they should be gathering and the problem-solving abilities they should be developing.

7. Pretest information should be made available to students and advice given to guide them in the selection of optional content materials. Students who have apparent competence in a topic area should be advised not to repeat that content.

8. Students do appear to place a great deal of confidence in their prior academic achievement in high school biology courses. Students with better backgrounds may be unwilling to spend the time to relearn somewhat familiar content materials and place greater efforts and time on less familiar and more openingly demanding, lecture courses.

Some problems for further research. Continued improvement in the teaching environment may require an increasing flexibility in learning procedures to be effective with an increasingly heterogeneous student body. College instruction geared toward the individual seems to have the greatest potential of upgrading achievement. Although independent study programs have been in use at the college level for some time the audio-tutorial approach to learning is a relatively recent innovation. Additional research in the area of audio-tutorial teaching and learning seems highly important and this study points to further research that needs to be undertaken. Some of the problems are:

1. What is the extent to which academic achievement is related to academic ability in the audio-tutorial course?

2. What combination of classroom direction and independent work make for the most effective learning in the audio-tutorial course?

3. What are the specific behavior and attitude changes accomplished in the audio-tutorial course?

4. What factors characterizing student approaches to learning tasks are illustrated by students with varying attitudes in the audio-tutorial course?

5. What attitude changes are evident in students taking the second level biology course at Lyman Briggs College which are not found in entering biology students?

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APPENDICES

APPENDIX A

STUDENT PREPARATION AND INTENT QUESTIONNAIRE

APPENDIX A

LBC 140[a] - THE ORGANISM AND ITS ENVIRONMENT
STUDENT PREPARATION AND INTENT QUESTIONNAIRE
Winter Term 1969

Please answer the following questions as they refer to you, your high school biological preparation, and your career intentions.

Please fill in all the blanks and encircle answers of questions to which you are directed.

Name_________________________________ Student No.________
Last   First Initial

Local Address________________________Local Phone____________

Home Town and State____

High School Attended_______________No. of Students__________
(in Grades 9-12)

How many terms have you completed at Michigan State?________

1. Did you have a "High School Biology" course in junior high or high school?
   a. Yes (answer question #2 next)
   b. No (answer question #12 next)

2. At which of the following grade levels did you take your first "High School Biology" course?
   a. Grade 7 or 8 (Answer question #3 next)
   b. Grade 9 (Answer question #3 next)
   c. Grade 10 (Answer question #3 next)
   d. Grade 11 (Answer question #3 next)
   e. Grade 12 (Answer question #3 next)

3. Which of the following responses are applicable to the textbook you used in your first "High School Biology" course?
   a. BSCS Blue Version (Molecules to Man) (Answer question #4 next)
   b. BSCS Green Version (High School Biology) (Answer question #4 next)

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

c. BSCS Yellow Version (Biological Science: An Inquiry into Life) (Answer question #4 next)

d. Some other textbook (Answer question #7 next)

4. Did you have a second or an advanced level biology course in high school?
   a. Yes (Answer question #5 next)
   b. No (Answer question #10 next)

5. What was the length of your second level or advanced biology course?
   a. One semester (Answer question #6 next)
   b. Two semesters (Answer question #6 next)

6. Which text(s) did you use?
   a. BSCS Advanced text (Answer question #10 next)
   b. Some other college text (Answer question #10 next)
   c. Pamphlets and/or booklets (Answer question #10 next)
   d. Some combination of the above (Answer question #10 next)

7. Did you have a second level or advanced biology course in high school?
   a. Yes (Answer question #8 next)
   b. No (Answer question #10 next)

8. What was the length of your second level or advanced biology course?
   a. One semester (Answer question #9 next)
   b. Two semesters (Answer question #9 next)

9. Which text(s) did you use?
   a. BSCS Version (Answer question #10 next)
   b. BSCS Advanced text (Answer question #10 next)
   c. Some other college text (Answer question #10 next)
   d. Pamphlets and/or booklets (Answer question #10 next)
   e. Some combination of the above (Answer question #10 next)

10. Did your high school work seem to concentrate in at least one unit on ecology?
   a. Yes (Answer question #11 next)
   b. No (Answer question #11 next)

11. How well does your overall background seem to apply to the following content areas? KEY: 1 = Excellent; 2 = Average; 3 = Poor.
   ___________ a. Terrestrial Ecosystem
   ___________ b. Aquatic Ecosystem
   ___________ c. Man in the Ecosystem

__________ d. Flowering Plant in the Terrestrial Ecosystem
__________ e. A Mammal in the Terrestrial Ecosystem
__________ f. Plants and Animals in the Aquatic Ecosystem
(Answer question #12 next)

12. Have you ever attended a summer program designed specifically for high school science students at some college or university?
    a. Yes (Answer question #13 next)
    b. No (Answer question #14 next)

13. What subjects did you study at the summer institute for high school science students and at which institution was the institute given? ________________________
    ____
    (Answer question #14 next)

14. Do you plan a career in the biologically oriented science?
    a. Yes (Answer question #15 next)
    b. No (Answer question #15 next)

15. What specifically do you intend your career area or speciality to be upon completing an AB degree and possibly graduate work?
    ____
    ____
    (Answer question #16 next)

16. Place a check in front of those packages you intend to complete. (You must take Packages 1, 2, and 3. At least one other Package must be selected for 3 credit hours. Other optional Packages are valued at one credit hour each.
    __________ a. Package One - A Terrestrial Ecosystem (Required)
    __________ b. Package Two - The Aquatic Ecosystem (Required)
    __________ c. Package Three - Man in the Ecosystem (Required)
    __________ d. Package Four - A Flowering Plant in a Terrestrial Ecosystem (Optional)
    __________ e. Package Five - A Vertebrate in the Terrestrial Ecosystem: (Optional)
    __________ f. Package Six - Plant and Animal Life in an Aquatic Ecosystem (Optional)
    (Answer question #17 next)

17. If you checked a total of 4 packages above place check here /___/ and answer #18 next.

    If you checked a total of 5 or 6 packages above place check here /___/ and answer #19 next.

18. I am choosing only one of the optional packages above because: (encircle best answer)
    1. I needed no more than 3 hours credit to fill a schedule
    2. I needed no more than 3 hours credit to fill a schedule and I hope to register for the other package some other term.
    3. My academic preparation warrants omitting the other packages.
    4. Only one of the optional packages interests me.
    5. None of the optional packages interests me but I had to enroll in one. (Answer #20 next)

19. I am choosing a total of 5 or 6 packages above because: (encircle the best answer)
    1. I needed 4 credits to fill my schedule.
    2. I needed 5 credits to fill my schedule.
    3. I needed 4 credits to fill my schedule and I hope to finish the sixth package some other term.
    4. I was advised to take 6 packages and retain the continuity developed within the entire course.
    5. My poor academic preparation warrants taking six packages.
    6. I think I can do well in them.

    (Answer question #20 next)

20. What things worry you about this course?

21. What things give you confidence at the beginning of this course?

APPENDIX B

COURSE ACHIEVEMENT TEST AND COVER SHEET

APPENDIX B

LBC 140[a] - THE ORGANISM AND ITS ENVIRONMENT
COURSE ACHIEVEMENT TEST
Winter Term 1969

DIRECTIONS: Place your name on this sheet and the provided answer sheet. Mark the proper spaces on the answer sheet to record your student number. Select the best answer to each question and record it by filling in completely the proper answer space. Erase all changed answers and extraneous marks. Answer the questions for the packages you completed first. Sub-scores will be found for each set of questions. Scores will be the total number of correct answers for each set. Only the answers given for the packages you completed will be used for grading purposes.

Questions 1-40 are for:	Package 1 - The Terrestrial Ecosystem
	Package 2 - The Aquatic Ecosystem
	Package 3 - Man in the Ecosystem
Questions 41-60 are for:	Package 4 - Sugar Maple in the Terrestrial Ecosystem
Questions 61-80 are for:	Package 5 - Rat in the Terrestrial Ecosystem
Questions 81-100 are for:	Package 6 - Plants and Animals in the Aquatic Ecosystem

All students take Package 1, 2, and 3 /XX/ and
Select one of the following:

Package 4	/__/	LBC 140 (3 Hours Credit)
Package 5	/__/	
Package 6	/__/	

Mark any additional Packages you selected for optional credit:

Package 4	/__/	LBC 290 (maximum 2 packages - 1 hour each)
Package 5	/__/	
Package 6	/__/	

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

<u>THE ORGANISM AND ITS ENVIRONMENT</u>

Package One - The Terrestrial Ecosystem
Package Two - The Aquatic Ecosystem
Package Three - Man in the Ecosystem

DIRECTIONS: Place your name on the provided answer sheet. Blacken the proper spaces to record your student number. Select the best answer to each question and record it by filling in completely the proper answer space. Erase all changed answers and extraneous marks. There are 40 questions to provide answers for. Your score is the total number of correct answers.

1. A decaying log and all the organisms living in and on it could best be considered:
   1. a society.
   2. a population.
   3. an organismal unit.
   4. a community.
   5. an ecosystem.

2. Carbon is made available to most consumers by:
   1. the activities of decay organisms.
   2. the activities of green plants.
   3. rain falling through the atmosphere.
   4. upheavals in the earth's crust.
   5. carbonification.

3. If precise quantitative measurements are made on a confined ecosystem in a laboratory we will find amounts of which of the following to be a one-way flow rather than cyclic?
   1. Carbon.
   2. Free energy.
   3. Nitrogen.
   4. Oxygen.
   5. Potassium.

4. The vegetation on a bare rock proceeds through the years from lichens to mosses, then in the crevices to ferns and other herbaceous plants, and finally to trees, which continue as permanent residents of the area. This is an example of:
   1. succession.
   2. adaptation.
   3. a hydrosphere.
   4. selection.
   5. a food chain.

5. When biologists refer to a balance of nature, they mean that there is little change over the course of years in:
   1. the number of plants and animals present.
   2. the organismal requirements and environmental productivity.
   3. the number of a particular kind of plant or animal.
   4. the number of a particular kind of producer or consumer.
   5. the number of immigrations and emigrations.

6. Physiological tolerance ranges are:
   1. the same for all the individuals of a given population.
   2. the result of hypothetical limiting factors.
   3. generally illustrated on a population basis rather than an individual basis.
   4. the same for all factors in the environment of an organism.
   5. often exceeded by individuals of a population.

7. Which of the following lists shows an increasing complexity in biological organizational levels?
   1. Molecule, tissue, population, community, ecosystem.
   2. Cell, individual, community, population, ecosystem.
   3. Organism, organ, ecosystem, community, population.
   4. Molecule, organ, ecosystem, population, community.
   5. Tissue, organism, community, ecosystem, population.

8. Competition for food, light, space, etc. is probably most severe between two:
   1. closely related species occupying the same niche.
   2. closely related species occupying different niches.
   3. unrelated species occupying the same niche.
   4. unrelated species occupying different niches.
   5. species in different overlapping ecosystems.

9. Which of the following does NOT represent a way in which a single sugar maple tree is like a population of sugar maple trees?
   1. It may increase in biomass with time.
   2. It is subject to genetic change.
   3. It is sensitive to temperature changes in the environment.
   4. It is subject to parasitism.
   5. It may have a cyclical pattern of growth.

10. What is the function of the decomposer in the food web?
    1. Return energy to the air for use by the producers.
    2. Release minerals from dead organisms for use by other organisms.
    3. Increase available energy in the system.
    4. Decrease the mineral supply.
    5. To provide food for consumers.

11. Urban areas have a higher food web energy level than rural areas. This is an unnatural type of ecosystem because:
    1. there are more producers than consumers.
    2. the producers and the consumers are almost equal in number.
    3. the normal energy pyramid is reversed.
    4. there are more consumers than producers.
    5. normally food webs are cyclical.

12. Which best describes a self-contained spacecraft?
    1. Organ system
    2. Population.
    3. Community.
    4. Ecosystem.
    5. Biosphere.

13. Living things are composed of matter and use energy for life's activities.
    Matter and energy:
    1. both circulate or move in cycle from nonliving to living things, back to nonliving and again into the living things.
    2. both pass from nonliving to living things but are then lost and are never used again.
    3. differ in that matter moves in cycles but energy does not.
    4. differ in that matter is mostly carbon dioxide and energy is mostly oxygen.
    5. differ in that matter is expended while energy is conserved.

14. A dynamic equilibrium would be most characteristic of a community that:
    1. has not yet started succession.
    2. is undergoing rapid succession.
    3. is at the end of its succession.
    4. is slowly undergoing succession.
    5. is in its lag phase of growth.

15. Although populations remain relatively constant over long periods they fluctuate or oscillate about the constant or average. The regulation of populations has been called a form of homeostasis. Which best describes the relation of the oscillations to homeostasis?
    1. The larger the oscillations, the more efficient the homeostatic mechanism.
    2. The smaller the oscillations, the more efficient the homeostatic mechanism.
    3. The more frequent the oscillations, the more efficient the homeostatic mechanism.

4. The less frequent the oscillations, the more efficient the homeostatic mechanism.
5. There is no relationship between oscillations and homeostasis.

16. The energy flow through fungi and bacteria is:
    1. equal to the sum of all energy in the organisms higher in the food web.
    2. less than the energy in all the organisms high in the food web.
    3. dependent on the energy fixed by producers.
    4. circulated through the entire ecosystem by a series of transfers.
    5. not restricted since they are at the base of a pyramid of numbers.

17. Ecological succession:
    1. always progresses through the same series of plant types.
    2. always is community controlled.
    3. always arrives at a beech-maple climax community.
    4. is unaffected by normal biological processes.
    5. is caused by the specific physical environment present.

18. The use of energy entering an organism from the outside is nearly 100% efficient in:
    1. unicellular green plants.
    2. all green plants.
    3. unicellular animals.
    4. bacteria.
    5. no known organism.

19. A biologist studying an ecosystem would be most concerned with:
    1. determining population changes in the area being investigated.
    2. making measurements of regional variations in temperature, wind velocity, and precipitation.
    3. analyzing the inter-relationships of both living and non-living components of the region.
    4. determining the effects of parasites on plants and animals found in the region.
    5. noting the environmental changes over time and its effect on the organisms living there.

20. As man studies living systems he selects certain individuals, populations, communities, and ecosystems for his investigations. The information obtained can never be complete and accurate because:

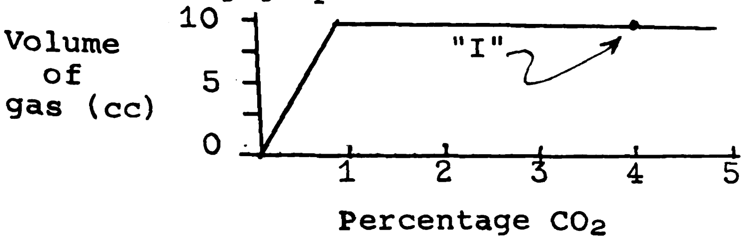
1. man is not capable of this task.
2. there are always new and undiscovered factors with which man cannot cope.
3. by selecting one level for intensive study we miss many inter-relationships.
4. man himself is a part of the ecosystem.
5. most niches cannot be observed.

21. If plants are grown at various wave lengths of the light spectrum, the greatest growth would be expected for those grown in the:
1. violet and ultraviolet range.
2. green range.
3. red and blue range.
4. yellow and orange range.
5. green and orange range.

22. Which of the following best characterizes a dystrophic lake?
1. Low energy utilization.
2. Extremely clear water.
3. Heavy silting.
4. Fall stratification.
5. Presence of rooted aquatics especially near the shore.

23. During summer months temperate zone lakes stratify. Water in the hypolimnion:
1. is colder than the surface and therefore has a higher oxygen content.
2. is warmer than the surface and therefore has a lower oxygen content.
3. is colder than the surface and has an equal oxygen content.
4. is warmer than the surface and has an equal oxygen content.
5. is colder than the surface but has a lower oxygen content.

24. Illuminated *Elodea* leaves give off bubbles of gas at 20°C. A plot of the volume of gas emitted in a given time interval against CO_2 concentration is shown on the following graph.



If the hypothesis principle of "limiting factors" is valid, then the volume of gas given off should increase at point "I" if:
1. more CO_2 is added.
2. the temperature is decreased.
3. the light intensity is increased.
4. more water is added.
5. less O_2 is present.

25. Elodea leaves were ground in acetone and the sediment was filtered through cheese cloth. The Spectronic 20 was used to measure relative absorbance of this extract. A blank of acetone was used to obtain zero absorbance. This was done because:
    1. the Spectronic 20 is accurate only in the range of 300 to 500 millimicrons and this increases its range.
    2. the acetone absorbs the UV which would otherwise give false readings.
    3. the acetone has its own absorbancy and thus must be subtracted out originally.
    4. the acetone has essentially zero absorbancy and the instrument must be calibrated against that.
    5. the acetone is quickly destroying chloroplasts and therefore zero readings would occur if this were not corrected.

26. During a particular Michigan winter an ice cover occurred early in the fall just following the fall turnover. A period of several days followed that were sunny but cold enough to maintain the ice cover. Shortly after this a heavy snow fall completely covered the lake. The next spring when the ice melted large numbers of fish were found dead along the shore. A probable cause for the kill was:
    1. the fish froze to death during the cold weather.
    2. nutrients were unavailable and the fish starved to death.
    3. the warm sun on the ice caused increased fish activity which used up the oxygen.
    4. an algal bloom followed by excessive decay raised the oxygen demand.
    5. increased photosynthesis caused depletion of CO_2 which was needed as a buffer.

27. Which of the following does NOT illustrate a characteristic of water?
    1. The density of ice is less than that of water at $0^{o}C$.
    2. Its latent heat of evaporation is useful in cooling animals and plants.
    3. Its specific heat is greater than other liquids under room temperature.

4. One calorie is required to change 1 gram of ice at $0^{\circ}C$ to water at $0^{\circ}C$.
5. Has a dipolar moment, its large polymer attributed to hydrogen bonding.

28. In any aquatic system carbon dioxide is important because it is the primary carbon source for photosynthesis and because it:
    1. aids animal circulation.
    2. forms a complex with toxic pollutants.
    3. forms carbonic acid which serves as a buffer.
    4. decreases plant respiration.
    5. aids bacteria in decomposition activities.

29. Hydrogen bonding occurs in water when:
    1. positive hydrogens exactly cancel a negative oxygen making water quite neutral.
    2. two positive hydrogens form a 105 degree angle with a single oxygen.
    3. part of the water molecule remains positively charged and the other part negatively charged.
    4. positive hydrogens of one water molecule attract the negative oxygens of others.
    5. water has a positive dipole moment.

30. In a fairly deep body of water, there is apt to be more biomass on or near the bottom than at most other levels. Yet, the energy of sunlight, on which living organisms depend, diminishes rapidly in being passed through water. The best of the following ways of accounting for this apparent paradox is:
    1. all photosynthesizing plants must be rooted in the bottom to obtain minerals.
    2. organic minerals continually drop to the bottom of the water.
    3. the animal population on the bottom converts enough carbon dioxide to organic compounds to supply all nutritive needs.
    4. all organisms must have a solid substratum to support them.
    5. temperature is more uniform at the bottom than anywhere else.

31. The most common unit of evolutionary change is the:
    1. ecosystem.
    2. community.
    3. individual organism.
    4. population.
    5. species.

32. Assume that a new method is found to remove continuous cores 1 foot in diameter and 2,000 feet long from the earth. Examination of thousands of cores would probably reveal that as one goes from tip (surface) to bottom (inward) the number:
    1. and kinds of fossils decrease.
    2. and kinds of fossils remain constant.
    3. and kinds of fossils increase.
    4. of fossils decreases but the kinds increase.
    5. of fossils increases but the kinds decrease.

33. Which of the following best states the evolution theory?
    1. Evolution is the maintenance of life under changing conditions.
    2. Evolution is the survival of the fittest.
    3. Evolution is the descent of humans from lower animals.
    4. Evolution is goal-directed change.
    5. Evolution is variation.

34. Both plants and animals are made of tiny units called cells; they use oxygen to release energy from their food; they may store food reserves as fat; these facts:
    1. provide information that all life had a common origin.
    2. support the idea that being alive is about the same in all living units.
    3. indicate that plants evolved from animals.
    4. support the idea that animals have gradually evolved from plants.
    5. support the diphyletic theory.

35. Which of the following is a characteristic of all primates?
    1. 1200-1500 c.c. brain capacity.
    2. Differing amounts of body hair.
    3. Upright posture with bipedal locomotion.
    4. Opposable thumb.
    5. High foot arches and ten toes.

36. Which of the following statements concerning a comparison between man and the great ape is (are) correct?
    1. Man has shorter arms and longer legs than the ape.
    2. Man has a smaller cranium but larger toes than the ape.
    3. Man has smaller but more canines than the ape.
    4. Both man and the ape have vertical spines.
    5. Two of the above answers are correct.

37. Which of the following is most important in determining the direction of evolution of an animal species.
    1. High mutation rate for certain traits.
    2. Independent assortment and recombination of certain traits.
    3. Selection of certain traits by environmental conditions.

4. The gradual change of certain traits by environmental conditions.
5. "An inner desire to survive in the face of change."

38. From the point of view of evolution, the greatest advantage of sexual reproduction is:
    1. the variety of animals and plants it can produce.
    2. the consistency of traits that will appear generation after generation.
    3. continuance of the species.
    4. the fact that a smaller percentage of eggs is fertilized.
    5. that it encourages social mating and ranking.

39. Which of the following is evidence that man no longer has biological (as opposed to cultural) self-regulation of his population?
    1. War has been practically eliminated.
    2. The birth rate has remained high despite insufficient food and a decrease in death rate.
    3. Outbreaks of serious diseases failed to reduce the population.
    4. Man has no predators and few parasites which he can't control.
    5. Population growth has been constant for centuries.

40. Which of the following illustrates the proper sequence of events postulated in the theory of evolution for the origin of life?
    1. Organic compounds--colloids--coacervates--self-replicating systems--stable metabolism.
    2. Colloids--organic compounds--coacervates--stable metabolism--self replicating systems.
    3. Coacervates--organic compounds--colloids--stable metabolism--self replicating systems.
    4. Self replicating systems--coacervates--colloids--organic compounds--stable metabolism.
    5. Organic compounds--stable metabolism--colloids--coacervates--self replicating systems.

THE ORGANISM AND ITS ENVIRONMENT

Package Four: A Flowering Plant in the Terrestrial Ecosystem.
Part A: The Primary Plant Body of Sugar Maple.
Part B: The Secondary Plant Body and Reproduction.

DIRECTIONS: Place your name on the provided answer sheet. Blacken the proper spaces to record your student number. Select the best answer to each question and record it by filling in completely the proper answer space. Erase all changed answers and extraneous marks. There are 20 questions to provide answers for. Your score is the total number of correct answers.

41. The primary function of guard cells in green plants is to:
    1. control the amount of light entering.
    2. allow carbon dioxide to escape.
    3. allow water vapor to enter.
    4. control the exchange of gases.
    5. allow internal osmotic pressures to be decreased.

42. What is the biological significance of mitosis?
    1. Genetic continuity within an organism is assured during cell division.
    2. Gamete formation is made possible.
    3. One cell can produce two daughter cells.
    4. The reduction division prevents a doubling of genetic material during fertilization.
    5. Concentration of soluble nuclear materials is placed in equilibrium with the rest of the cell.

43. The development of large size in land plants is especially correlated with:
    1. increased efficiency in asexual reproduction.
    2. insect pollination.
    3. specialization of vascular tissues.
    4. appearance of an electron transport system.
    5. development of a cambium.

44. Adventitious roots:
    1. originate from the radicle of the seed.
    2. originate from primary and secondary root pericycle.
    3. are functional plant organs.
    4. are thickened and elongated root hairs.
    5. are produced from plant stems and leaves.

45. If a ring of bark around a tree were removed the tree would die because:
    1. water would not be available for food production.
    2. its protection has been destroyed and disease would kill it.

3. no more xylem or phloem could be formed.
4. the roots would have their food supply cut off.
5. the tree would no longer have storage areas.

46. Branch roots have their origin from:
1. epidermal cells.
1. axillary buds.
3. pericycle cells.
4. primary meristem.
5. young root hairs.

47. How could you determine the length of time required to produce a certain length of a sugar maple twig?
1. Count axillary buds.
2. Count annular rings.
3. Count bud scale scars.
4. Count bundle scars.
5. Count leaf scars.

48. The vascular tissue of a young root of a flowering plant is so arranged that:
1. xylem surrounds phloem tissue.
2. phloem surrounds xylem tissue.
3. radiating xylem tissue has phloem in the bays between the xylem arms.
4. secondary growth cannot occur.
5. radiating phloem tissue has xylem in the bays between the phloem arms.

49. Perennial plants:
1. produce seeds twice a year in a two year growing cycle.
2. Produce seeds each year in a two growing season cycle.
3. Require two growing seasons to complete vegetative and reproductive processes.
4. live from year to year with varying reproductive periods.
5. are always herbaceous.

50. The tissue in plants which gives rise to all other plant tissues is called:
1. sclerenchyma tissue.
2. parenchyma tissue
3. permanent tissue
4. meristematic tissue
5. mature tissue.

51. A monecious plant has:
1. sepals and petals only in its flowers.
2. only staminate flowers.
3. only pistillate flowers.
4. both staminate and pistillate flowers.
5. perfect flowers.

52. Recall the last time you had lima beans for dinner. Which of the following fruit parts did you include in your meal?
    1. Exocarp, mesocarp, endocarp, and pericarp.
    2. Mesocarp, endocarp, and pericarp.
    3. Only mesocarp and endocarp.
    4. Only mesocarp.
    5. None of the above.

53. A fruit is:
    1. an enlarged succulent peduncle.
    2. a ripened ovary and attached parts of one or more flowers.
    3. a seed specially and specifically adapted for dispersion by animals.
    4. a ripened ovule containing one or more undeveloped plants and stored food for nourishment.
    5. an accumulation of endosperm to be used by an embryo after it is planted and begins to absorb water.

54. Regarding alternation of generations:
    1. the sporophyte generation begins at fertilization and ends with meiosis.
    2. the sporophyte generation begins with mitosis and ends with fertilization.
    3. the gametophyte generation begins with fertilization and ends with mitosis.
    4. the gametophyte generation begins with mitosis and ends at the time of fertilization.
    5. both the gametophyte and sporophyte generation begin with fertilization and end with meiosis.

55. Annual rings in a tree are the result of:
    1. differences in the size of phloem cells produced during a single growing season.
    2. differences in the length of the vascular rays produced during a single growing season.
    3. difference in the amount of cork tissue produced during a single growing season.
    4. differences in the size of xylem cells produced during a single growing season.
    5. differences in the amount of pith produced in a single growing season.

56. In the Christmas holly some trees produce flowers which have only pistils and other trees produce flowers which have only stamens. Which should be planted to obtain branches that bear red berries?
    1. Pistillate trees.
    2. Staminate trees.
    3. Both pistillate and staminate trees.
    4. Sterile trees.
    5. Sports.

57. How far from the terminal bud on a tree branch does the youngest annual ring extend?
    1. Down to the adjacent bud scale scar.
    2. Down to the adjacent node.
    3. Throughout the branch and tree trunk down to the root.
    4. Down to the adjacent bundle scar.
    5. Down the branch to the trunk proper.

58. A three-quarter inch upholstery nail is driven full length into a trunk of a tree whose bark is one inch thick. The tree grows one inch in diameter each year. At the end of four years (assuming that none of the bark has been weathered or sloughed off) the nail head will be:
    1. flush with the surface of the bark.
    2. buried in the tree trunk.
    3. pushed out some distance from the bark.
    4. buried in the bark.
    5. none of the above.

59. What is the biological significance of meiosis?
    1. During cell division a constant amount of genetic material is retained.
    2. When the fertilized egg divides the number of chromosomes is reduced.
    3. The amount of genetic material is halved to prevent a doubling up of genetic material during fertilization.
    4. It ensures the continuity of germplasm.
    5. None of the above.

60. What purpose does bark serve in the woody dicot plant?
    1. Protection from mechanical injury.
    2. Storage of food materials.
    3. Translocation of food materials.
    4. Support of phloem elements.
    5. All of the above.

THE ORGANISM AND ITS ENVIRONMENT

Package Five: A Vertebrate in the Terrestrial Ecosystem
Part A: Anatomy and Physiology of a Selected Vertebrate.
Part B: The Animal in its Environment.

DIRECTIONS: Place your name on the provided answer sheet. Blacken the proper spaces to record your student number. Select the best answer to each question and record it by filling in completely the proper answer space. Erase all changed answers and extraneous marks. There are 20 questions to provide answers for. Your score is the total number of correct answers.

61. Mammals are successful with small eggs, while lower vertebrates produce larger eggs. Why?
    1. Mammalian eggs are fertilized by a simpler process.
    2. Mammals are the only vertebrates that care for their young.
    3. The land egg makes it possible for reptiles to live away from bodies of water.
    4. Mammalian embryos receive nourishment from the blood of the mother.
    5. The blood of the mother circulates through the mammalian embryo.

62. Which does <u>not</u> demonstrate the interrelationship between form and function?
    1. Spherical shape of the nucleus and storage of DNA.
    2. Convoluted tubules and glomerular filtrate reabsorption.
    3. Moist membrane and gaseous exchange.
    4. Muscle fibrils and contraction.
    5. Extension of nerve cell (axons and dendrites) and impulse condition.

63. The rat life cycle is completed in about:
    1. 21-23 days.
    2. 3-4 months.
    3. 1 year.
    4. 3 years.
    5. None apply, litters are produced continuously throughout the year.

64. When a muscle contracts:
    1. fibers stretch like elastic.
    2. different kinds of filaments slide past each other.
    3. tendons shorten.
    4. individual filaments shorten.
    5. sixty per cent of the available chemical energy is converted to mechanical energy.

65. A certain mammal has a $\frac{2.1.2.3.}{2.1.2.3.}$ dental formula. How many canine and molar teeth does the animal have?
1. 8
2. 10
3. 12
4. 16
5. 20

66. Skeletons of aquatic animals can be less bulky and less strong than those of land animals of the same size because of the:
1. need of more protection on land.
2. buoyancy of water.
3. larger size of land animals.
4. presence of pseudopodal rather than bipedal locomotion.
5. need for quadrapedal suspension in land animals.

67. What is a probable advantage of social ranking among rats?
1. It reduces energy spent in fighting for food, space, etc.
2. It enables specialization of behavior patterns for certain tasks as protection and reproduction.
3. It produces strong, central leadership.
4. It provides for general conformity.
5. It eliminates a pseudo caste system.

68. The liver is an important rat structure. Why?
1. It secretes hydrochloric acid.
2. It secretes bile salts to be stored in the gall bladder.
3. It converts glucose to glycogen and stores it.
4. Its many villi make protein absorption possible.
5. It secretes a hormone essential for the normal metabolism of sugar.

69. The kidneys perform two major functions. What are they?
1. They excrete the end products of metabolism and regulate elimination from the digestive tract.
2. They control the concentration of most constituents of the body fluids and excrete the end products of metabolism.
3. They excrete the end products of metabolism and regulate bile secretion.
4. They excrete the end products of metabolism and the substances used in the digestive processes.
5. They excrete the end products of metabolism and excrete waste drugs.

70. What is the value of a rat's belly muscles?
1. They help to increase head flexibility.
2. They help to keep the backbone up-curved.
3. They provide limb motility.

4. They allow places for the storage of brown fat.
5. They push internal organs into place.

71. If two species of rats whose distribution ranges and ecological niches overlap are competing then:
1. a new species will arise in the overlapping zone because of hydridization.
2. both species will coexist in the overlapping zone if the environment is different from either "specific zone".
3. both species will coexist in the overlapping zone if the environment is like one "specific zone".
4. each species distribution will end abruptly in the middle of the overlapping zone.
5. one species will eventually "take over" the overlapping zone.

72. The best evidence that an organism is surviving in a particular environment is its:
1. amount of population biomass.
2. record of emigration.
3. successful reproduction.
4. spot in the social pecking order.
5. position in the food chain.

73. In a certain ecosystem field mice are preyed upon by snakes and hawks. The entrance of wild cats into the system adds another predator on the mice. Of the following the most likely short-term result of this addition is:
1. increase in snake population.
2. tendency for hawks to prey on the cats.
3. extinction of the hawks.
4. reduction in number of mice.
5. migration of hawks to another ecosystem.

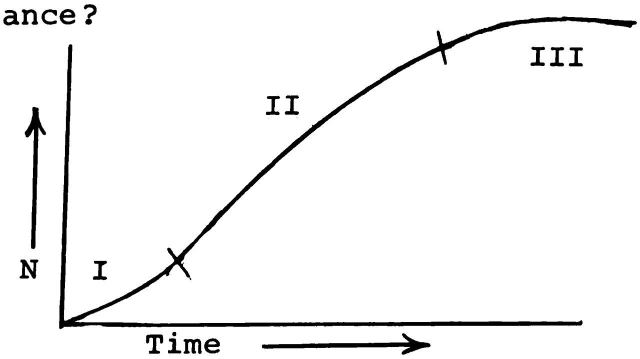
74. In ecological terms, the adaption of an animal refers to its:
1. ways of modifying its environment.
2. rate of mutational change made to increase its survival.
3. fitness for a particular kind of life.
4. modification due to effects of the environment.
5. reproductive or biotic potential.

75. In general, the animals higher in the scale of vertebrate life can maintain their species with fewer eggs. Why?
1. The higher vertebrates are better adapted to their environments than the lower ones.
2. The higher vertebrates give greater care to their eggs and their offspring.
3. Sexual reproduction is characteristic of the higher vertebrates while asexual reproduction characterizes the lower vertebrates.

4. Internal fertilization characterizes the reproduction of all vertebrates.
5. The higher vertebrates do not produce enough sperms to fertilize as many eggs as are produced by the lower vertebrates.

76. Generally the factors tending to prevent increases in population size of higher vertebrates to the extent of overcrowding, and decreases to the point of extinction, are those that are:
1. primarily related to control by predator populations.
2. dependent upon population size for their effectiveness.
3. acting independently of population size and with cyclical frequency.
4. operating independently of population size and with irregularly fluctuating frequencies.
5. controlled by burrow metabolism.

77. A population growth gives the following curve when numbers (N) or organisms are plotted against time: At which portion of the curve does the unchecked rate equal the environmental resistance?
1. I
2. II
3. III
4. I and II
5. I, II, and III



78. Which of the following identifies a population?
1. In 1967 there were 204 of them.
2. 38,672 students enrolled.
3. 204 mature rats.
4. Rats in Sanford Natural Area on April 1, 1968.
5. 210 on April 7, 1968.

79. The size of a population is primarily determined by:
1. current death rate.
2. average birth rate.
3. ratio between normal birth and death rates.
4. available energy.
5. emigration and immigration.

80. In an animal community the smallest animals usually:
1. are primary producers.
2. are third-order consumers.
3. have the least biomass.
4. illustrate the most carrying capacity.
5. have the highest reproductive rate.

THE ORGANISM AND ITS ENVIRONMENT

Package Six: Life in an Aquatic Ecosystem
Part A: Plant Life in an Aquatic Ecosystem
Part B: Animal Life in an Aquatic Ecosystem

DIRECTIONS: Place your name on the provided answer sheet. Blacken the proper spaces to record your student number. Select the best answer to each question and record it by filling in completely the proper answer space. Erase all changed answers and extraneous marks. There are 20 questions to provide answers for. Your score is the total number of correct answers.

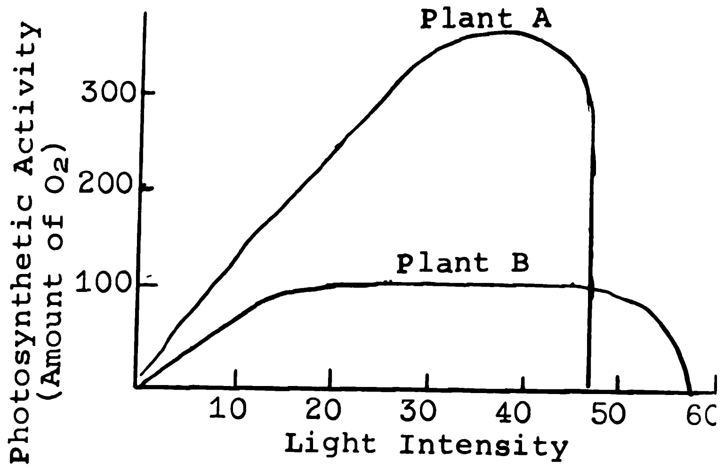
81. Which of the following does not limit the depth in water to which light can penetrate?
    1. Water turbidity.
    2. Amount of absorption by water.
    3. Density of plankton.
    4. Depth of water.
    5. Light intensity.

82. Which of the following are characteristic of the lower tropholytic or hypolimnion zone?
    1. Respiration exceeds photosynthesis.
    2. Photosynthesis exceeds respiration.
    3. Decomposition compensates for the low, non-effective light penetration making it trophogenic.
    4. Respiration balances photosynthesis.
    5. 2 and 3 above.

83. Respiration is a process which involves:
    1. the release of energy.
    2. the storage of energy.
    3. both storage and release of energy.
    4. the same energy change as in photosynthesis.
    5. none of the above.

84. A man is surface-sterilized and placed in a lighted, germ-free capsule with a tank containing only green algae (Chlamydomonas sp.) and sterile distilled water. The man's wastes are placed in the tank and he drinks only filtered water from the tank and eats only algae. The man is not likely to survive. Why?
    1. He contracts disease from the contaminated water.
    2. The algae are unable to use the nitrogen in the air or in the man's wastes.
    3. The algae supply only carbohydrates for the man's food.
    4. Man cannot live without a wide variety of organisms around him.
    5. Man cannot evolve so that he can use atmospheric nitrogen.

85. Plant A would be better suited than plant B for living in:
1. artificial light.
2. light having an intensity of 50.
3. light of all intensities.
4. total darkness.
5. the shade.



86. Which of the following characterize Oedogonium and Ulothrix?
1. One has isogametes and the other heterogametes.
2. One has a holdfast for its attachment to substrate while the other doesn't.
3. One illustrates an alternation of generation while the other doesn't.
4. One consists of a single cell and the other a colonial aggregation.
5. Both have special sex organs which are different from vegetative cells.

87. Which of the following regarding alternation of generations in plants is correct?
1. The algae (Ulothrix) sporophyte and gametophyte are equal in size.
2. The algae (Ulothrix) sporophyte is smaller than the gametophyte.
3. In flowering plants the sporophyte and gametophyte are equal in size, each being independent.
4. In flowering plants the gametophyte is larger than the sporophyte; each is dependent on the other.
5. None of the above.

88. Unlike sexual reproduction, asexual reproduction means to the species that:
1. the species will be continued.
2. the offspring will be different.
3. the offspring will be a duplication of its parents.
4. a great deal of genetic material is available to the evolutionary process.
5. variations of type will continue to occur.

89. When their environment changes, living organisms:
    1. produce adaptations as a direct response to the new environment.
    2. may survive if they already have suitable variations.
    3. must move to a better area, and let others move in.
    4. change in ways which cannot be predicted.
    5. are unaffected.

90. Which of the following characterizes a diatom?
    1. Minute green spheres with a cuplike chloroplast.
    2. Yellow green or golden brown in pigmentation.
    3. Microscopic pillboxes arranged in a thread-like filament.
    4. Most useful as a food additive.
    5. Anchored by a small multicellular holdfast.

91. Although two cells unite in the process of fertilization, the zygote of animals generally has no more chromosomes than the number typical of the body cells of the parents. Why?
    1. Meiosis occurs during the process of gametogenesis.
    2. In parthenogenesis, eggs develop which have not united with a sperm.
    3. Cleavage occurs following the fertilization of an egg by a sperm.
    4. Sperms contain fewer chromosomes than eggs.
    5. Mitosis occurs during the process of gametogenesis.

92. Which example of living material represents the greatest total expenditure of energy in the system?
    1. One pound of soft green grass.
    2. One pound of plant lice.
    3. One pound of mice.
    4. One pound of snake.
    5. Pound for pound energy expenditures are equal.

93. As we proceed down the classification table from kingdom to species we see:
    1. more diversity in organisms.
    2. less similarity in organisms.
    3. more similarity in organisms.
    4. increasing complexity in organisms.
    5. none of these.

94. The clam life cycle differs from that of a rotifer in that the clam:
    1. has sexual reproduction.
    2. has a parasitic larval stage.
    3. has an aquatic adult life, but a terrestrial larval one.
    4. has a short life span while the rotifer has a long one.
    5. has species level characteristics while the rotifer has only generic ones.

95. Assimilation is a metabolic process in which:
    1. organic materials are synthesized within organisms.
    2. organic materials are taken into organisms.
    3. food materials are broken down into components usable by organisms.
    4. organic materials are changed into organismal structures.
    5. energy is made available at organismal structures.

96. Why would you expect phytoplankton blooms to occur 2 times during the year in temperate regions?
    1. Semi-annual turnovers bring most organisms living in the aquatic environment back into the epilimnion.
    2. Temperature stratification is unrestrictive after semi-annual turnovers.
    3. Nutrients are most readily available to phytoplankton in early spring and late fall.
    4. Semi-annual turnover reduces the limiting factors.
    5. All of the above.

97. Which of the following organisms found in a pond would you consider scavengers?
    1. Clam.
    2. Crayfish.
    3. Daphnia.
    4. Copepods.
    5. Rotifers.

98. Which of the following animals is a diploblast?
    1. Rotifer.
    2. Planaria.
    3. Hydra.
    4. Didinium.
    5. Crayfish.

99. The diphyletic theory divides the animal kingdom into large groups. The names of these groups are:
    1. protozoa and metazoa.
    2. bilaterial and radiata.
    3. acoelomate and eucoelomate.
    4. protostomia and deutorostomia
    5. arthropoda and echinodermata.

100. Of what value is a resting egg in a <u>permanent</u> pond in Michigan?
    1. It allows the survival of the egg through temporary drying conditions.
    2. It permits an accumulation of food for the embryonic development which is to occur.
    3. It allows eggs laid in the fall to begin rapid development in the spring.
    4. It prevents overcrowding by not allowing all eggs to develop at once.
    5. It provides only for an exchange in genetic material without any further value.

APPENDIX C

COURSE EVALUATION QUESTIONNAIRE AND COVER SHEET

APPENDIX C

LBC 140[a] - THE ORGANISM AND ITS ENVIRONMENT

Winter Term 1969

Information has been collected this term to provide for continuous improvement of LBC 140. The information you have provided will be most helpful to the LBC staff in determining which changes will be made in the course. Future LBC students will benefit by any suggestions you can make as to where and what kind of change is needed. Your co-operation is requested in the following ventures:

1. Please provide responses to the items found on the attached questionnaire relating to your participation in the LBC program and return the booklet and the completed, but unsigned, IBM response sheet to the final exam on March 12, 1969.

2. Gain scores for each student will be available for evaluation and analysis if you will complete all of the questions on the final exam. We are interested in determining if the content you selected helped your to gain understanding in the packages you did not select. You should respond to the items relating to the packages you completed first and then the others. Only the scores for the content you selected will be used to determine your course grades.

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

LBC 140 - THE ORGANISM AND ITS ENVIRONMENT
COURSE EVALUATION QUESTIONNAIRE
Winter Term 1969

Attached is a questionnaire which is part of a LBC 140 research study. All of your answers should be placed on a scoring sheet with a #2 pencil. Your name should not be placed on the sheet.

The positive statements to which you are being asked to respond are divided into four sections. These sections refer to: The Total Program, The Large Assembly Session, The Individual Study Session, and The Recitation and Response Session. You are asked to select one of the five responses placed at the top of the response columns and to blacken one space corresponding to that response on the scoring sheet. Please respond to each item only as you feel it applies to the indicated setting. Mark the spaces as follows:

Mark "1" if you STRONGLY AGREE

Mark "2" if you AGREE

Mark "3" if you have NO BASIS FOR OPINION

Mark "4" if you DISAGREE

Mark "5" if you STRONGLY DISAGREE

Use the last page to clarify any of the responses you have made or to add any recommendations or additional comments.

THE TOTAL PROGRAM:	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	-------Percentage-------				
1. LBC 140 has been among the most interesting courses I have taken in either Briggs College or the University.		36[a]	18	46[a]	
2. LBC 140 has been among the most intellectually satisfying courses I have taken in either Briggs College or the University.		17	20	62[b]	
3. LBC 140 has been more difficult for me than other courses I have taken in either Briggs College or the University.		44	18	38	
4. One of the objectives of LBC 140 was to teach facts.		37	13	51	
5. One of the objectives of LBC 140 was to teach general principles (generalizations).		82	9	9	
6. One of the objectives of LBC 140 was to teach application skills.		58	18	25	
7. One of the objectives of LBC 140 was to teach problem solving skills.		48	23	30	
8. One of the objectives of LBC 140 was to teach attitudes.		41	30	29	

[a]Agree categories and disagree categories have been combined.

[b]Percentages shown do not always total 100% due to omits and rounding off of subtotal results.

THE TOTAL PROGRAM:	Strongly Agree / Agree	No Basis for Opinion	Disagree / Strongly Disagree
	Percentage		
9. One of the objectives of LBC 140 was to teach appreciations.	50	26	24
10. One of the objectives of LBC 140 was to instill a desire for further learning.	54	22	25
11. The level of my achievement as illustrated in evaluation scores seemed to be directly related to the amount of time I had available to spend on the course.	28	23	49
12. I experienced some difficulty in getting answers to questions in content areas where I found understanding difficult.	53	22	25
13. Instructors were readily available to help with student problems that required their personal attention.	47	31	23
14. Most students seemed to believe that LBC 140 was more interesting than other college courses.	16	27	58
15. Most students seemed to believe that LBC 140 was more intellectually satisfying than other college courses.	8	30	61
16. Most students seemed to find LBC 140 more difficult than other college courses.	50	31	19
17. I had to spend more time to complete the work expected in LBC 140 than in my other Briggs College or University courses which offered equal credit.	49	11	40

THE TOTAL PROGRAM:

	Strongly Agree / Agree	No Basis for Opinion	Disagree / Strongly Disagree
	------Percentage-----		
18. Most students seemed to spend more time to complete the work expected in LBC 140 than in other courses offering equal credit.	40	34	26
19. The testing or evaluation procedure which was used in LBC 140 was adequate for grading purposes.	24	10	66
20. My test scores and subjective grades adequately evaluated my understanding of the LBC 140 materials as noted by the course and individual content package objectives.	25	17	57
21. LBC 140 made a contribution toward my ability to find and assemble facts.	40	23	37
22. LBC 140 made a contribution toward my ability to associate and evaluate facts.	48	23	28
23. LBC 140 made a contribution toward my ability to draw valid conclusions from facts.	43	20	37
24. LBC 140 made a contribution toward my comprehension in the areas of biology studied during the course.	73	9	18
25. LBC 140 made a contribution toward my intellectual interest in ecology.	54	11	35
26. LBC 140 made a contribution toward my awareness of ecological relationships.	84	6	10

THE TOTAL PROGRAM:

	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	------	Percentage		-----	
27. I based my choice of a selected amount of content in LBC 140 on the amount of study time I would have available.		49	12	38	
28. Students generally seemed to base their choices of a selected amount of content in LBC 140 on the amount of study time they hoped to have available.		41	42	17	
29. I selected my LBC 290 packages to parallel my interests rather than to remove subject area deficiencies which existed in my academic preparation.		33	27	39	
30. I found it difficult to make a selection from the content packages available for credit and extra credit because of a conflict between the importance of filling in subject matter background deficiencies and my desire to succeed in those packages I chose.		27	34	39	
31. Students should be given more help in choosing which packages of LBC 140 they should take.		43	35	22	
32. When beginning LBC 140 I liked the idea of being able to take an audio-tutorial course.		71	8	22	
33. Having completed LBC 140 I liked the experience of having taken an audio-tutorial course.		56	4	39	

LARGE ASSEMBLY SESSION:	Strongly Agree / Agree	No Basis for Opinion	Disagree / Strongly Disagree
	------Percentage	-----	-----
34. The Large Assembly Session was a necessary part of the learning-experience format of LBC 140.	44	13	42
35. The learning experiences presented in the Large Assembly Sessions helped to increase the general interest I had in LBC 140	52	13	34
36. The learning experiences presented in the Large Assembly Sessions helped to make LBC 140 intellectually satisfying.	48	17	35
37. The learning experiences presented in the Large Assembly Sessions helped to make LBC 140 intellectually stimulating.	50	17	32
38. The Large Assembly Sessions were coordinated with the Individual Study Session materials.	48	15	36
39. Guest speakers discussed material relative to LBC 140	66	14	19
40. The films used in the Large Assembly Sessions introduced new materials not presented in the Individual Study Sessions.	49	20	30
41. The film used in the Large Assembly Sessions presented and explained materials which were later used in the Individual Study Sessions.	56	20	25
42. Sufficient time was allowed during the Large Assembly Sessions for the discussion of student questions.	44	20	36
43. Five to ten minute topic lectures generally would be of more value in the Large Assembly Sessions than long lectures.	25	28	47

LARGE ASSEMBLY SESSION:	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	------Percentage-----				
44. Five to ten minute topic lectures generally would be of more value in the Large Assembly Sessions than the films that were used.		30	29	41	
45. The Large Assembly Session would have been more effective if more content had been presented in planned topic lectures.		42	31	26	
46. The score I received on the test given in the Large Assembly Session was indicative of my understanding of the subject matter presented in the Individual Study Sessions.		22	11	66	
47. The testing in the Large Assembly Session relative to the content packages was illustrative of an adequate content sample for grading purposes.		20	18	63	

INDIVIDUAL STUDY SESSION:	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	------	Percentage	------		
48. The opportunity for self-directed study as provided in LBC 140 Individual Study Sessions has been intellectually more rewarding for me than college classroom lectures usually are.		47	18		35
49. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions has resulted in a more efficient use of my LBC 140 study time.		49	18		32
50. My intellectual satisfaction throughout LBC 140 has been directly related to the time I could spend on the materials presented in the Individual Study Sessions.		42	18		38
51. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions made a contribution toward my ability to find and assemble facts.		37	20		41
52. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions made a contribution toward my ability to associate and evaluate facts.		40	19		48
53. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions made a contribution toward my ability to draw valid conclusions from facts.		41	20		37
54. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions made a contribution toward my comprehension in the areas of biology studied during the course.		70	12		16

INDIVIDUAL STUDY SESSION:	Strongly Agree / Agree	No Basis for Opinion	Disagree / Strongly Disagree
	------Percentage-----		
55. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions made a contribution toward my Intellectual interest in ecology.	53	11	35
56. The opportunity for self-directed study as provided in the LBC 140 Individual Study Sessions made a contribution toward my awareness of ecological relationships.	69	11	17
57. The level of my understanding of the LBC 140 materials seemed to be directly related to the time I had available for the study of the materials in the Individual Study Sessions.	46	10	41
58. The amount of noise and distraction around the Individual Study carrel environment hindered effective individual study.	16	10	71
59. The package content materials for the Individual Study Sessions have been readily available for student use.	63	9	24
60. The objectives for each package of content used in the Individual Study Sessions were clearly pointed out.	77	6	13
61. The Individual Study Session materials emphasized relationships rather than minute detail.	58	13	26
62. I planned a convenient sequence of time blocks on a weekly basis for using the study materials presented in the Individual Study Sessions.	46	11	40

INDIVIDUAL STUDY SESSION:	Strongly Agree / Agree	No Basis for Opinion	Disagree / Strongly Disagree
	------Percentage-----		
63. The flexibility inherent in LBC 140 fosters putting off Individual Study Sessions until some other time and thus results in minimal use of the facilities.	37	16	44
64. I am able to operate a microtome and can prepare mounts of suitable materials for microscopic examination with ease.	40	13	43
65. I can work with the microscope used in the study carrels and displays as evidenced by my ability to find, focus, and vary the light intensity and magnification for wet and dry mounts with ease.	68	11	18
66. Adequate instruction was presented to facilitate my initial use of the buttons and switches found in each study carrel.	72	8	17
67. The directions given in the taped study programs were sufficient to direct me through the experiences provided.	56	10	30
68. Adequate instructional material was provided for the "do-it-yourself" projects and experimental work that I was asked to do in the Individual Study Sessions.	43	11	42
69. I completed less than 50% of the activities that were directed to be done outside the carrel.	30	5	61
70. I completed more than 75% of the activities that were directed to be done outside the carrel.	47	6	44

<u>INDIVIDUAL STUDY SESSION:</u>

	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	Percentage				
71. My participation in most of the presented activities outside the study carrel in the Individual Study Sessions were not essential to an understanding of the package content.		62	13	20	
72. The Individual Study Session should provide more "do-it-yourself" projects and experiments for maximum program effectiveness.		22	28	47	
73. The slide sequences as presented and programmed into the tape are a necessary part of the Individual Study Session.		72	10	14	
74. Slide sequences as presented during the Individual Study Sessions are more useful than "do-it-yourself" projects.		49	23	24	
75. The prepared study guides and outlines were useful in helping me to organize the materials presented in the Individual Study Session.		80	6	10	
76. The study guides prepared for the Individual Study Sessions should have more informative content and fewer questions.		64	13	18	
77. For every hour I spent in the Individual Study Session, I spent less than 1½ hours studying elsewhere with the text, study guides, and references.		60	9	27	
78. For every hour I spent in the Individual Study Session, I spent between 1½ and 3 hours studying elsewhere with the text, study guides, and references.		26	7	63	

<u>INDIVIDUAL STUDY SESSION:</u>

	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	-----Percentage------				
79. For every hour I spent in the Individual Study Session I spent three hours or more studying elsewhere with the text, study guides, and references.		10	8	79	
80. I spent more time outside the Individual Study Session reviewing with the study guides and my associated notes than studying with the text.		44	9	41	
81. I spent more time outside the Individual Study Session studying with the text than with other references.		49	7	39	
82. Outside references were useful in helping me gain an understanding of the materials presented in the Individual Study Sessions.		31	38	27	
83. A study carrel was available for my use at the time I needed one.		54	5	37	
84. An insufficient number of study carrels for those enrolled prevented my weekly use of the prepared materials.		19	12	65	
85. Graduate assistants have generally been able to assist me in my progress with the Individual Study Session materials.		30	35	32	
86. Student assistants have generally been able to assist me in my progress with the Individual Study Session materials		49	23	25	

<u>RECITATION AND RESPONSE SESSION:</u>

	Strongly Agree / Agree	No Basis for Opinion	Disagree / Strongly Disagree
	------Percentage-----		
87. The time available for Recitation and Response Sessions was used to facilitate an expression of individual student achievement.	51	13	32
88. Students do most of the talking in the Recitation and Response Sessions.	66	9	21
89. My preparation for participation in the Recitation and Response Sessions made a contribution toward my ability to find and assemble facts.	45	20	31
90. My preparation for participation in the Recitation and Response Sessions made a contribution toward my ability to associate and evaluate facts.	45	18	33
91. My preparation for participation in the Recitation and Response Sessions made a contribution toward my ability to draw valid conclusions from facts.	39	17	40
92. My participation in the Recitation and Response Sessions made a contribution toward my comprehension in the areas of biology studied during the course.	66	11	20
93. My participation in the Recitation and Response Sessions made a contribution toward my intellectual interest in ecology.	37	15	44
94. My participation in the Recitation and Response Sessions made a contribution toward my awareness of ecological relationships.	58	13	24

RECITATION AND RESPONSE SESSION:

	Strongly Agree	Agree	No Basis for Opinion	Disagree	Strongly Disagree
	------	Percentage	-----		
95. I have found the study guides to be more effective than either the text or other references in preparing for the Recitation and Response Sessions.		56	19	21	
96. The appropriateness of my participation in the Recitation and Response Sessions seemed to be directly related to the amount of time I had spent on the content packages.		51	17	28	
97. The quality of my recitation and response seemed to be directly related to my understanding of the content package materials.		58	14	24	
98. Oral recitation and the chance to respond to the recitation of others has been more helpful to me in gauging my accomplishment than written quizzes have been.		46	22	28	
99. The scores I received on my oral recitation and relevant responses are indicative of my understanding of the course content as noted by the objectives of LBC 140 and the content packages.		37	28	32	
100. The scoring technique relative to the Recitation and Response Session was an adequate procedure for grading purposes.		43	19	34	
101. The Recitation and Response Session meets student need relative to the Session purpose.		30	18	42	

If you wish to clarify any of the responses you made, please do so here:

If you were to improve the structure of LBC 140 what would you do to each of the following sessions to improve them?

1. Large Assembly Session:

2. Individual Study Session:

3. Recitation and Response Session:

Please add any additional comments you wish to make on the nature and operation of L BC 140:

APPENDIX D

LBC 140
DESCRIPTION OF METHODOLOGY

APPENDIX D

LBC 140[a]

DESCRIPTION OF METHODOLOGY

Lyman Briggs Biology 140 (The Organism and its Environment) is a three credit course with an ecological emphasis which uses an audio-tutorial approach. This approach may be broken up into three different kinds of learning experiences in which you will participate. The three parts are as follows:

1. The Large Assembly Session. All students in the course will meet together in a single group once a week. The purposes of these sessions are:
   a. To show specially selected films.
   b. To answer questions which may have arisen in the other activities of the course.
   c. To discuss briefly major concepts or current topics.
   d. To have an occasional quest speaker.
   e. To have a common examination period for hour exams (see schedule for exam dates)

2. The Recitation and Response Session (R & R). A maximum of ten students will be assigned a 50 minute period once a week and each student will be allowed to respond orally on some aspect of the previous week's materials. The response procedure will be as follows:
   a. The instructor in charge will select an item to be discussed and a student will be chosen by lottery to discuss the item.
   b. Student order of recitation will be done at the beginning of the period by the student selecting a numbered disc from a group of discs which have been previously scrambled and the numbers masked.
   c. Each student will be expected to respond at every session, but the order of response should be random throughout the term.
   d. The instructor will choose the item to be discussed and ask the question, "What is this?" The student whose turn it is to respond will identify the item (an item may be any object used in the program).

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

e. The instructor will then ask the student what the objective was in using this item in the learning procedure.
f. Finally the student is allowed to tell what he knows about the item.
g. At the end of the response time (usually about 3 minutes) the instructor will assign a numerical grade to the student on the basis of his or her response. Grading will be on the following basis.

<u>Nine Points</u>	The student identified the item, identified the objectives, knew about the item in that he understood the concept illustrated.
<u>Seven Points</u>	The student could not either identify the item or didn't know the objectives or was weak in understanding the concept.
<u>Five Points</u>	The student could not identify the item or could not identify any objectives or had little or no understanding of the concept.

h. Once the student has completed his response, the discussion of the item is thrown open to any who wish to add or make corrections. Additions or corrections are to be made in rank order thus the first student to respond has the first chance to correct, etc. In this way a student who had done poorly in his original response could recover some of his lost points by adding or correcting on future responses.

The purpose of this session is twofold. First it is an assessment of the Individual Study Session and second it is a mechanism by which you as students may teach each other.

3. The Individual Study Session. As the term individual implies you can move along through the material at a rate which is suited to your individual needs and previous learning experiences. In this way you are independent of your classmates. This is accomplished by using audio-tape programmed along with slides and various "typical" laboratory exercises such as use of a microscope, dissection, observations, and interpretations of graphs and charts. A tape deck playback unit is used in the audio portion of the program to give verbal instruction.

Each block of content is called a content package, and each package has a study guide which is designed to direct you through the Individual Study Session, ask pertinent questions and assign readings. At the beginning of each study guide there is a statement as to the general objectives for that unit. The questions posed throughout the study guide should serve to imply the specific objectives for the program.

As you progress through any given study guide you will notice that at times there are drawings to complete, tables to be filled in, and usually questions to be answered. We will not ask for these to be handed in, but they should serve to guide you in your study.

APPENDIX E

LBC 140

STUDY GUIDE FOR PACKAGE NUMBER ONE

TERRESTRIAL ECOSYSTEM: PART A--DESCRIPTIVE ECOLOGY

APPENDIX E

LBC 140[a] - Biology I

Package Number One -- Terrestrial Ecosystems
Part A -- Descriptive Ecology

Study Guide

Contents

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

I. POINTS OF EMPHASIS

A. Objectives:
1. To consider the organizational levels of life.
2. To structure the concept of a terrestrial ecosystem.
3. To consider Sanford Natural Area as an example of a terrestrial ecosystem in order to help you understand this concept.
4. To characterize the world's major ecosystems (biomes).

B. Operational Mechanics.

The structure of this individual study session consists of a tape recording about the concept of a terrestrial ecosystem with visual aids and demonstrations keyed into the tape. You will be told when to change the tape and when to leave the carrel for observations at a demonstration area. When conducting an observation at one of these areas please turn off the tape recorder and turn the projector back to the fan position before leaving the carrel.

If, at any time during this individual study session, you fail to understand directions or have questions regarding the materials, turn off the equipment and ask your instructor for assistance.

II. BIOLOGY, THE SCIENCE THAT DEALS WITH ORGANISMS

A. The Biological Ship. Reference: Platt and Reid, Bio Science, pp. 4-5.
1. Question Set Number One:
   a. What are the organizational levels of life?
   b. List several factors which comprise the physical environment.
   c. In what ways could the factors of the physical environment be influenced by the biological systems?
   d. In what ways could the factors of the physical environment affect the biological systems?

B. The Analogy of the Biological Ship Emphasizes that:
1. It is the individual organism that meets the challenge of existence.
2. The field of biology is predominantly organism oriented. That is, we study man, the rodent, disease organisms, domestic and wild animals and plants, etc.
3. An understanding of the organism is predicated as much on knowledge of its external environment as of its internal environment.
4. Knowledge gained through research in the external environment is coordinate in importance with that gained through the internal environment.

C. A Point of View Regarding the Biological Ship.

1. Statement:

The success or failure of an organism is dependent upon two primary controls:

a. Its genetic character as determined at the molecular level--DNA and RNA.

b. The evaluation of living systems from molecule to ecosystem is toward achieving increasing control of the physical environment.

2. Question Set Number Two:

a. Give some examples which show how the genetic characteristics of an organism determine its success or failure within a given physical environment.

b. What is your interpretation of the statement: "The Balance of Nature?"

III. TERRESTRIAL ECOSYSTEMS

A. Components of the ecosystem:

1. The abiotic (nonliving) component: Basic elements and compounds of the physical environment.

2. The biotic (living) component: Trophic (food) Levels.

a. Autotrophic Level: Producers

1. Green Plants

2. Chemosynthetic Bacteria

b. Heterotrophic Level

1. Consumers

a. Direct or grazing herbivores

b. Indirect carnivores and detritus--feeding saprovores

2. Decomposers

a. Fungi of decay

b. Bacteria of decay

B. Question Set Number Three:

1. List some of the basic elements and compounds which make up the abiotic component of a terrestrial ecosystem.

2. Give some examples of the autotrophic organisms associated with a terrestrial ecosystem.

3. Give some examples of the heterotrophic organisms associated with a terrestrial ecosystem.

4. What is the energy source of a terrestrial ecosystem?

5. What role do bacteria and fungi play in a terrestrial ecosystem?

IV. ECOLOGICAL SUCCESSION

A. Odum's Parameters of Succession:

1. It is an orderly process of community changes; these are directional and, therefore, predictable.

2. It results from modification of the physical environment by the community.
3. It culminates in the establishment of as stable an ecosystem as is possible on the sight in question.

B. Demonstration One:
   1. Primary Succession.
      a. A Hydrosere.

The pioneer sequence of succession in a lake or pond having deep water is frequently called the bare bottom stage. Algae, bacteria, protozoa, insect larvae, snails, crustacea, and fish are the characteristic organisms. With the passage of time the lake or pond becomes partially filled with humus, and then becomes favorable for the invasion, growth, and development of different species of organisms.

The next seral stage consists of submerged aquatic plants, which accumulate after their death and decay and, together with silt deposits, gradually raise the lake bottom. Conditions are now favorable for the development of other species of algae and various pondweeds. Dragonfly, Mayfly, nymphs, and additional species of crustacea, snails, and fish are associated with this stage of succession. Ultimately, a suitable water depth and a richer substrate for other invaders is formed.

Various species of floating plants begin to invade the area occupied by the submerged plants which migrate mainly by underground stems from their stronghold in the shallower water. Common among the floating plants are various water lilies and pondweeds. As these invaders increase in numbers, their leaves occupy more of the water surface and the amount of light available for submerged plants is decreased. Often the mass of unattached floaters, such as duckweed, cover the surface and aid materially in reducing the light. Due to the dense tangle of stems, much water-borne soil is deposited in the floating plant zone, and the decay of the dead bodies of many species builds up the substrate.

The floating stage is replaced by a reed-swamp sequence. The tall bulrush, cattail, and reeds invade the area occupied by the floating plants. Many other species, such as arrowheads, water plantain, and sweet flag are common associates in this stage of seral changes. These species, the immergents, cause a decrease in water depth which makes the habitat less fit for them, but more favorable for the next sequence, the sedge-grass stage. As the taller species of the reed-swamp stage disappear, light conditions become more favorable and the sedges, grasses, mints, and bedstraws become established.

Finally, the sedge-grass stage becomes too dry and the sequence is replaced by another community. Depending on the regional climate, this stage could result in a climax grassland, a deciduous forest, or a coniferous forest biome.

b. Study the pictorial model of a hydrosere and determine the seral changes which take place in this kind of primary succession.

c. The single concept, film loop, "Evolution of a Lake" is pertinent to this concept of systems ecology, and should be viewed while at this demonstration area.

2. Secondary Succession.

Secondary succession occurs when there is an interruption in the seral sequence of a primary successional development. Here, a part or all of the community may be so disturbed that an earlier stage of the sequence is re-established on the site. Such a disturbance may be caused by fire, clearing by man, livestock grazing, wind throw, flooding deposition, landslip, or snowslides.

This pictorial model shows secondary succession on abandoned agricultural fields in the Piedmont Region of Southeastern United States. In the late summer or fall, following cultivation, crabgrass is usually dominant. During the first year of abandonment, when the fields are not too severely eroded, horseweed, conspicuous because it is 4 to 6 feet tall, and crabgrass are frequently dominant; however, ragweed may share in the dominance. During the second year, aster usually becomes the dominant with horseweed and crabgrass still present. During the third year, broomsedge assumes dominance and maintains it for a number of years until replaced by pine trees. In due time the climax oak and hickories occupy the area.

3. Soil.

Succession must always be accompanied by the development of a soil. Vegetational succession and soil development go hand in hand; they can't be separated, nor can one reach stability without the other.

a. Soil Profiles.

If we were to examine the cut edge of a trench we would see that the soil is composed of several distinct layers. These layers are termed horizons, and the sequence of horizons from the surface down is called a soil profile.

It is customary to designate these horizons by letters: The upper layer as the A horizon; the next lower horizon as the B; the third as the C; and the deepest layer, or bedrock, as the D horizon. Each horizon may be further subdivided for purposes of identifying the various stages of soil forming processes. Thus, the A horizon may be subdivided into the A_{00} layer (leaf litter and undecomposed organic debris);

A_0 layer (matted and decomposed organic material); A_1 (some leaching of minerals evident and a high proportion of finely divided organic material present, consequently dark in color); and A_2 portion, which represents the zone of maximum leaching, is light in color. The B horizon is the zone of maximum accumulation of materials leached from above. This horizon may be divided into several subsections depending on the degree of accumulation of leached materials in evidence. The C horizon is a zone of parent material which, as a whole, is assumed to be similar to that which was on the surface before the soil-forming processes began.

b. Observations:

1) Observe the pictorial model of a soils map of Sanford Natural Area. Read Veatch, J. O., Soils and Lands of Michigan, for a description of the soil types shown by the map's legend.
2) Look at the soil profiles taken from Sanford Natural Area and then connect each profile with the proper area on the map by means of the attached string.
3) Study each of the soil profiles and determine the A, B, and C horizons. Where possible, identify any subdivisions of each profile which may be present. Sketch each profile with its horizons and subdivisions in the space below.

Soil Type:_____ Soil Type:_____ Soil Type:_____

C. Question Set Number Four: Ecological Succession.
1. Characterize the pattern of vegetational changes in a hydrosere.
2. What changes in the physical environment do the biological systems cause during succession in a hydrosere?
3. Construct a model showing the vegetational changes in a xerosere.
4. How does secondary succession differ from primary succession?
5. What are the essential abiotic and biotic factors operative in ecological succession.
6. Explain how Odum's parameters of succession are emphasized in a sequence of ecological succession.
7. How does Veatch characterize the vegetation for the soil types shown on the soils map of Sanford Natural Area?
8. Is Carlisle Muck a podzol or an organic soil?
9. In what respects does the Oshtemo soil type differ from the Genessee soil type? From the Berrien soil type?

V. SANFORD NATURAL AREA

A. Demonstration Two: Some representative plants and animals which may be found in Sanford Natural Area.

1. Presence List:
   a. Autotrophic Component.
      1) Forest Canopy:

Beech	<u>Fagus grandifolia</u>
Sugar Maple	<u>Acer saccharum</u>
Black Cherry	<u>Prunus serotinia</u>
White Ash	<u>Fraxinus americana</u>
American Elm	<u>Ulmus americana</u>
Basswood	<u>Tilia americana</u>
White Oak	<u>Quercus alba</u>
Red Oak	<u>Quercus rubra</u>

      2) Forest Understory:

Ironwood	<u>Ostrya virginiana</u>
Blue Beech	<u>Carpinus caroliniana</u>
Red Maple	<u>Acer rubrum</u>
Sassafras	<u>Sassafras albidum</u>
Flowering Dogwood	<u>Cornus florida</u>
Hackberry	<u>Celtis occidentalis</u>

      3) Forest Shrubs:

Spice Bush	<u>Lindera benzoin</u>
Leatherwood	<u>Dirca palustris</u>
Elderberry	<u>Sambucus canadensis</u>
Witch Hazel	<u>Hamamelis virginiana</u>
Bladdernut	<u>Staphylea trifolia</u>

Wafer Ash (Hoptree)	*Ptelea trifoliata*
Arrow Wood	*Viburnum dentatum*
Greenbrier	*Smilax rotundifolia*

4) Forest Vines:

Poison Ivy	*Rhus radicans*
Virginia Creeper	*Parthenocissus quinquefolia*
Wild Grape	*Vitis* sp.
Greenbrier	*Smilax herbacea*

5) Herbaceous Plants:

Columbine	*Aquilegia canadensis*
Jack-in-the-Pulpit	*Arisaema atrorubens*
Wild Ginger	*Asarum canadense*
Sedge	*Carex* sp.
Blue Cohosh	*Caulophyllum thalictroides*
Spring Beauty	*Claytonia virginica*
Toothwort	*Dentaria diphylla*
Trout Lily	*Erythronium americanum*
White Snakeroot	*Polygala senega*
Bedstraw	*Galium* sp.
Wild Geranium	*Geranium maculatum*
Nettle	*Urtica gracilis*
Sweet Cicely	*Osmorhiza claytoni*
May Apple	*Podophyllum peltatum*
Solomon's Seal	*Polygonatum pubescens*
Swamp Buttercup	*Ranunculus septentrionalis*
False Solomon's Seal	*Smilacina racemosa*
Goldenrod	*Solidago* sp.
Violet	*Viola* sp.
Skunk Cabbage	*Symplocarpus foetidus*

b. Heterotrophic Component.

The animals on display represent some of the macro-consumers (herbivores, carnivores, insectivores, and omnivores) and some of the microconsumers. Note the skull, teeth, and body adaptations of these animals.

1) Macroconsumers:

Deer	*Odocoileus virginianus*
Opossum	*Didelphis marsupialis*
Short-tailed Shrew	*Dlarina brevicauda*
Eastern Mole	*Sculopus aquaticus*
Raccoon	*Procyon lotor*
Least Weasel	*Mustela rixosa*
Short-tailed Weasel	*Mustela ereminea*
Skunk	*Mephitis mephitis*
Chipmunk	*Tamis striatus*
Red Squirrel	*Tamiasciurus hudsonicus*
Fox Squirrel	*Sciurus Niger*
Deer-Mouse	*Peromyscus meniculatus*
White-footed Mouse	*Peromyscus leucopus*
Porcupine	*Erethizon dorsatum*

Barn Owl	Tyto alba
Crow	Coruus brachyrhynchos
Downy Woodpecker	Dendrocopos borealis
Blue Jay	Cyanocitta cristata
American Toad	Bufo americanus
Tree Frog	Hyla versiocolor
Green Snake	Opheodrys vernalis
Blue Racer Snake	Coluber constrictor
Garter Snake	Thamnophis sp.
Red-basked Salamander	Piethodon cinereus
Spotted Salamander	Ambystoma maculatum

2) Microconsumers:

Earthworm	Lumbricus terrestris
Slugs	Limax sp.
Snails	Helicodiscus sp.
	Mesodon sp.
	Triodopsis sp.
	Helix sp.
	Succinen sp.
Ants	Formicidae
Bees	Apidae
Ichneumons	Ichneumonidae
Carabid Beetles	Carabidae
Rover Beetles	Staphglinidae
Scarab Beetles	Coocinellida
Blister Beetles	Meloidae
Click Beetles	Elatenidae
Leaf Beetles	Elatenidae
Crickets	Gryllidae
Martids	Maridae
Termites	Rhinctermitidae
Wolf Spiders	Lycosidae
Orb weaving Spiders	Argiopidae
Comb-footed Spiders	Theridiidae
Crab Spiders	Thomisidae
Jumping Spiders	Attidae
Black Widow Spiders	Latrodectus sp.
Mites	Acarina
Centipedes	Lilhobius sp.
Millipedes	Parajulus sp.
Pseudoscorpions	Pseudoscorpounida
Daddy Longlegs	Opiliones

3) Decomposers:

a) Fungi: Wood decaying (Fomes sp.)

b) Bacteria:

The importance of bacteria to natural plant communities is difficult to evaluate accurately, however, their significance is indicated by their functions of making nitrogen available by fixing it, or releasing it with other nutrients through their activities in decomposing organic matter. Digestion of proteins, ammonification, and nitrification must all occur before organic nitrogen can be used by plants, and a succession of bacteria must be present if the processes are to take place.

Observe the demonstration microscopes and answer the following questions:

(1) What trophic level do these organisms represent?
(2) What is their importance to a terrestrial ecosystem?

B. Question Set Number Five: Sanford Natural Area.

1. What are the dominant tree species of Sanford Natural Area?
2. What is the function of the autotrophic component of Sanford Natural Area?
3. What kinds of organisms are found in the heterotrophic component of Sanford Natural Area?
4. In what manner would such microconsumers as earthworms, slugs, and snails influence the physical environment of the soil?

VI. DISTRIBUTION OF THE WORLD'S MAJOR BIOMES

A. Demonstration: Distribution of the World's Major Biomes.

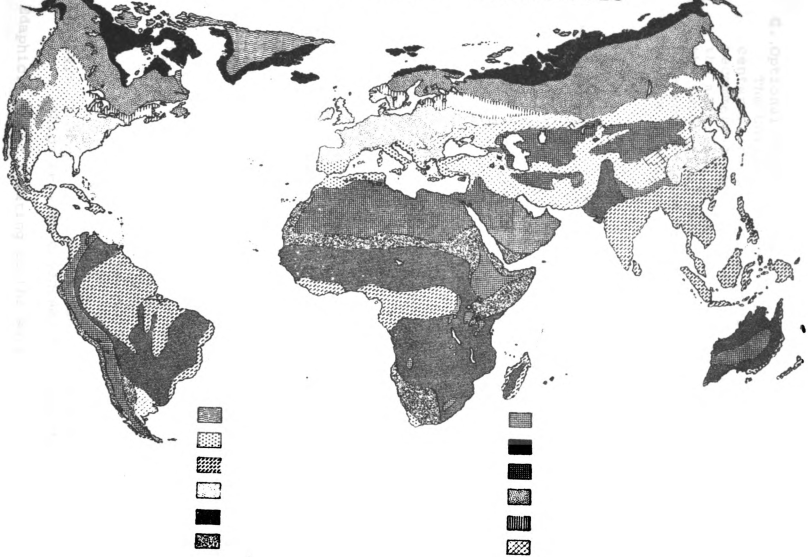
1. On display are several types of terrestrial ecosystems. In what climatic zone would each of these ecosystems be found?
2. Statement: Although the physiological development of an animal or plant is directed by its genetic characteristics, the extent to which the organism does develop is directed by its environment; that is, the proper conditions at the proper times and in the proper intensities and amounts.

   Would the animals shown in the several ecosystems be a success or failure in terms of the above statement?
3. On page 10 of the study guide is a map showing the distribution of the world's major biomes. The descriptive portion of the map's legend has been omitted from this map. Complete the map by supplying the proper descriptions opposite the legend's key.

B. Question Set Number Five:

1. What factors of the physical environment effect the distribution of the world's major biomes?
2. What is a climax ecosystem?
3. Contrast the tropical rain forest biome with the temperate rain forest biome.
4. Distinguish among: natural savannas, disturbed savannas, and grasslands.

WORLD DISTRIBUTION OF MAJOR BIOMES



5. In what way do differences in altitude affect biome distribution?
6. How do heat relations differ between deserts and humid lands?

C. Optional Observations.

The University Museum has several excellent displays centered around various types of ecosystems. It is recommended that you visit these displays to supplement the materials of package one. Particularly pertinent is the panorama of the geological time scale, located in the basement, and the major habitats of North America which will be found on the second floor.

VII. GLOSSARY

Abiotic: non-living things.

Ammonification: decomposition with production of ammonia or ammonium compounds, especially by the action of bacteria.

Autotrophic: referring to a plant which is able to manufacture its own food, e.g., green plants.

Biome: a large, natural assemblage of associated plants and animals, extending over large regions of the earth's surface.

Chemosynthetic: obtaining energy by oxidation of organic compounds.

Climax: a relatively permanent plant association which maintains itself with little change in a given region as long as there is no major changes in environmental conditions.

Deciduous: refers to plants which lose their leaves regularly each year, as opposed to evergreens, the leaves of which remain on the stems longer than a year.

Decomposer: heterotrophic organisms, chiefly bacteria and fungi, which break down the complex products of dead protoplasm, absorb some of the decomposition products and release simple substances usable by the producers.

Ecology: that part of biology which deals with the relationships between organisms and their environment.

Edaphic: of or relating to the soil.

Environment: the complex of climatic, edaphic, and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival.

Flora: the plants of a particular region or period.

Floristic: concerned with or relating to flowers or flora.

Herbaceous: plants which do not develop much woody tissue and thus remain soft and succulent.

Heterotrophic: obtaining nourishment from organic substances.

Lichens: plants composed of an alga and a fungus growing in symbiotic association.

Microclimate: the climate of small areas, as of confined spaces.

Nitrification: the oxidation (as by bacteria) of ammonium salts to nitrites and further oxidation of nitrites to nitrates.

Organism: an individual constituted to carry on the activities of life.

Predator: any animal which kills other animals for food.

Producers: plants which produce their own food, i.e., autotrophic.

Species: a population of interbreeding individuals.

Succession: an ecological, geological, or seasonal sequence of species; the development of plant communities.

Symbiosis: the living together in more or less intimate association or close union of two dissimilar organisms.

Terrestrial: of or relating to land as distinct from water.

Trophic Structure: energy level in a food chain of an ecosystem.

VIII. REFERENCES

A. Required:

Platt, R. B. and G. K. Reid. Bioscience. Pages 189-201.

B. Optional:
Allee, et al. Principles of Animal Ecology
Billings, W. D. Plants and the Ecosystem
Darlington, P. Jr. Zoogeography
Dice, L. R. Natural Communities
Gilman, J. C. A Manual of Soil Fungi
Life Nature Library: Ecology
Life Nature Library: The Forest
Life Nature Library: The Desert
Odum, E. P. Ecology
Odum, E. P. Fundamentals of Ecology
Oosting, H. J. Plant Communities
Richards, P. W. Tropical Rain Forest
Schery, R. W. Plants for Man
Smith, R. L. Ecology and Field Biology

IX. LIST OF SLIDES

Number	Title
1	The Biological Ship--Platt and Reid
2	Points of Emphasis--Biological Ship
3	A Forest Scene
4	Unicellular Organism
5	Terrestrial Ecosystem
6	Odum's Parameters of Succession
7	A Hydrosere
8	Secondary Succession
9	Sanford Natural Sign
10	Interior--Sanford Natural Area
11	American Beech
12	Sugar Maple
13	Species Reproduction
14	Flowering Dogwood
15	Poison Ivy
16	A Colony of Spring Beauty
17	Wild Geranium
18	Stinging Nettle
19	Canada Violet
20	Wakerobin or Trillium
21	A Population of May Apple
22	Jack-In-The-Pulpit
23	Hairy-Cap Moss
24	Christmas Fern
25	The Chipmunk
26	A Raccoon
27	The Opossum
28	A Squirrel
29	A Garter Snake
30	A Box Turtle

APPENDIX F

LBC 140

COURSE DESCRIPTION

APPENDIX F

LBC 140[a]
THE ORGANISM AND ITS ENVIRONMENT
COURSE DESCRIPTION

Package One: The Terrestrial Ecosystem

Part A: Descriptive ecology.

Considers the organizational levels of life. Structures the concept of a terrestrial ecosystem using the Sanford Natural Area to help in understanding the concepts of both the biotic and abiotic components. The world's major biomes are also characterized.

Part B: Energetics.

The point is made that an ecosystem is a natural system which has independence, except for an energy source; self-regulation and maintenance, balanced energetics, recycling of nonliving components, and both functional and interspecies diversity. As such it is the ultimate level of biological organization.

Package Two: The Aquatic Ecosystem

The physico-chemical properties of water are related to the organisms that inhabit this medium. The major aquatic medium considered is the lake. Energy flow through lakes is

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

discussed as well as lake evolution and annual lake cycles.

Package Three: Man in the Ecosystem

Emphasis in this unit is based on the conviction that Brigg's students should be aware of the physical and biological nature of man's environment and through this awareness contribute as citizens to wholesome and intelligent planning for the future. Some of the topics considered are: the population challenge, man's pollution of his environment, environmental health, resources--renewable and nonrenewable, wildlife management and recreation.

Package Four: A Flowering Plant in the Terrestrial Ecosystem

Part A: The Primary Plant Body.

Emphasis is placed on the importance of an individual organism as one type of ecological system. A sugar maple tree is used as a typical plant in order to develop an understanding of the form and function of the primary plant body.

Part B: The Secondary Plant Body and Life Cycle.

Growth and development of the secondary plant body of a sugar maple tree is followed through the activity of the vascular and cork cambiums. Reproductive processes are considered and the concept of an alternation of generations is presented.

Package Five: A Vertebrate in the Terrestrial Ecosystem

Part A: Anatomy and Physiology of a Selected Vertebrate.

The white rat is studied from the anatomical point of view. The names and locations of selected structures are studied and discussed in relationship to adaptation to terrestrial life.

Part B: The Animal in its Environment.

Emphasis in this unit is on the ecology of the Norway Rat including life cycle, food habits, reproduction and social and population interactions. Some of the structures and functions learned in Package Five, Part A, will be considered in relation to the organism and its environment.

Package Six: Life in an Aquatic Ecosystem

Part A: Plant Life in an Aquatic Ecosystem.

The zonation of a fresh water ecosystem is discussed and the plant life characteristics of the several zones described. The role of phytoplankton is emphasized with form, function and classification of the algae considered.

Part B: Animal Life in an Aquatic Ecosystem.

Selected aquatic invertebrates are studied with emphasis on their taxonomy, life cycles, and food habits. Animal phylogeny is also discussed.

APPENDIX G

LBC 140
SESSION SCHEDULES
FOR WINTER TERM, 1969

APPENDIX G

LBC 140[a]: LAS[b] SCHEDULE
Winter Term--1969

January 6	Terrestrial Ecosystems. Pre-test: Packages 1, 2, and 3.
January 13	Terrestrial Ecosystems Film: A Strand Breaks Concept: Energy Flow and Biogeochemical Cycles
January 20	Aquatic Ecosystem Film: Limnology Concept: Formation of a Bog
January 27	Man in the Ecosystem Guest Lecturer: Dr. Georg Borgstrom--Food Supply and Population Problems.
February 3	First Hour Examination Packages 1, 2, and 3
February 10	A Flowering Plant in a Terrestrial Ecosystem Guest Lecturer: Dr. William Drew--Economic Botany and the Ecosystem.
February 17	A Selected Vertebrate in a Terrestrial Ecosystem Guest Lecturer: Dr. John Cantlon--Population Dynamics.
February 24	Plant Life in an Aquatic Ecosystem Guest Lecturer: Dr. Brian Moss--Two African Lakes and Their Associated Biological and Human Problems.
March 3	Animal Life in an Aquatic Ecosystem Guest Lecturer: Dr. Arthur Reed--The Ecology of a Coral Reef.
March 12	Final Examination 12:45 - 2:45 p.m.

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[a]LBC 140 is the University designation for the biology course offered in Lyman Briggs College.

[b]Large Assembly Session.

LBC 140: R and R[a] Schedule
Winter Term--1969

January 6-10	Film: The Strands Grow Orientation: Individual Study Session
January 13-17	Pre-test: Packages 4, 5, and 6
January 20-24	Package One: Terrestrial Ecosystems
January 27-31	Package Two: Aquatic Ecosystem
February 3-7	Package Three: Man in the Ecosystem
February 10-14	Package Four: A Flowering Plant in a Terrestrial Ecosystem
February 17-21	Package Five: A Selected Vertebrate in a Terrestrial Ecosystem
February 24-28	Package Six: Part A. Plant Life in an Aquatic Ecosystem
March 3-7	Package Six: Part B. Animal Life in an Aquatic Ecosystem

[a]Recitation and Response Session.

LBC 140: ISS[a] Schedule
Winter Term--1969

REQUIRED PACKAGES

January 7-20	Package One:	Terrestrial Ecosystems
	Part A:	Descriptive Ecology.
	Part B:	Energetics.
January 21-27	Package Two:	Aquatic Ecosystem
January 28-February 3	Package Three:	Man in the Ecosystem

OPTIONAL PACKAGES

February 4-March 7	Package Four:	A Flowering Plant in the Terrestrial Ecosystem
	Part A:	Primary Plant Body.
	Part B:	Secondary Plant Body and Life Cycle.
	Package Five:	A Selected Vertebrate in the Terrestrial Ecosystem
	Part A:	Anatomy and Physiology of a Selected Vertebrate.
	Part B:	The Animal in Its Environment.
	Package Six:	Life in an Aquatic Ecosystem
	Part A:	Plant Life in an Aquatic Ecosystem.
	Part B:	Animal Life in an Aquatic Ecosystem.

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[a]Individual Study Session.

LBC 140: ISS[a] Hours
Winter Term--1969

DAY	SCHEDULED HOURS	STUDENT ASSISTANT IN CHARGE
Monday	2:00 - 5:00 P.M.	R. McCleese
	6:00 - 10:00 P.M.	D. Chapman
Tuesday	Carrel set up time all day	
	6:00 - 10:00 P.M.	R. Brockway
Wednesday	2:00 - 5:00 P.M.	C. Killian
	6:00 - 10:00 P.M.	R. McCleese
Thursday	8:00 - 12:00 A.M.	C. Killian
	12:00 - 2:40 P.M.	R. Brockway
	3:00 - 5:00 P.M.	A. Smith
	6:00 - 8:00 P.M.	D. Chapman
	8:00 - 10:00 P.M.	A. Smith
Friday	12:00 - 3:00 P.M.	R. McCleese
	3:00 - 6:00 P.M.	C. Killian
Saturday	9:00 - 12:00 A.M.	D. Chapman
	12:00 - 3:00 P.M.	A. Smith

[a]Individual Study Session.

LBC 140: Final Examination Rooms
Winter Term--1969
March 12: 12:45-2.45 P.M.

R and R SECTIONS	REGULARLY ASSIGNED STAFF MEMBER	EXAMINATION ROOM
12	Dr. Hagerman	C 105-106
5a 8a	Mr. D. Ray	C 105-106
2 4b 7 8b	Mr. P. Hoeksema	C 105-106
1 6a 9 10	Dr. Elliott	C 102
3 4a 5b 11	Mr. L. Clingenpeel	C 104