AN INVESTIGATION OF THE COLLEGE GENERAL BIOLOGY CURRICULUM AS AN INTEGRATED PART OF THE PRESERVICE TRAINING OF ELEMENTARY TEACHERS

By

DOROTHY ANN FROSCH

Bachelor of Science
Central State University
Edmond, Oklahoma
1958

Master of Teaching
Central State University
Edmond, Oklahoma
1964

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
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Thesis Approved:

Kenneth E. Wiggins
Thesis Adviser

Jerry Wilhm

Wm. D. Frazier

L. Herbert Bruneau

Franklin R. Leach

D. Durham
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Science curriculum has been in a state of flux for over a decade. The initial changes in science curriculum were brought about by the development of new materials for use in the secondary schools (39). The success of the new secondary science curriculum pointed up the urgency of improving the teaching of science in the elementary schools as well as in colleges. New science programs for the elementary schools are now available and many are currently used. Attention is now focused on college science teaching and preservice teacher education programs (55). The impact of the new curriculum in elementary and secondary schools is being felt at the college level and new innovations are being introduced (64).

The increased emphasis on the process approach to the teaching of elementary science and the development of guidelines and standards of elementary teachers demand the need for carefully planned college science curriculum. Introductory college biology as a part of that curriculum could greatly affect the future of science teaching. Olson (60) states that the future elementary teacher is an important student in any general biology class because as teachers they will help determine the attitude toward science and influence potential scientists. He indicates that these future teachers need special attention as freshmen in college biology courses.

The State Science Committee of The Oklahoma Curriculum Improvement Commission (78) recommends that college science teachers make an appraisal of the organization, content and methodology of their courses. If future teachers are required to teach science as inquiry then these prospective teachers should be taught by inquiry. They should gain an awareness that science is an intellectual, investigative process. What is done in college science courses will materially affect the way that elementary teachers teach science. It is important to provide elementary teachers with the educational opportunity not only to develop desired attitudes toward science but to acquire knowledge, skills and techniques so important in retaining the high quality teaching in this state.

This study was made to determine a model type of college general biology course for use in Oklahoma's institutions of higher education and the relation of such a course to the training of elementary teachers. The major purposes of the study are:

1. To determine the type of college general biology course which the Oklahoma college biology faculty believe would constitute a model course in Oklahoma's institutions of higher education.

2. To determine the type of college general biology course elementary teachers in Oklahoma believe would be most useful to them in the teaching of elementary science.

3. To develop an outline of a curriculum program for the college general biology nonscience major with special emphasis directed toward the preservice training of elementary teachers.

Statement of the Problem

Oklahoma institutions of higher education have a responsibility of providing the type of experiences and opportunities necessary to produce high quality elementary teachers. Part of this responsibility lies within the realm of each college educator either as a part of the general education program or as a part of a specialized area. The achievement of a well integrated, meaningful program is dependent upon careful planning and implementation of comprehensive learning experiences. The success of such a program requires a unified effort on the part of the college faculty to study the existing problems, outline the goals and objectives and initiate a curriculum plan which will lead toward these goals. The success is also dependent upon the participation of the college faculty in a periodic evaluation of course content and methodology, their knowledge of new curriculum developments and an awareness of the problems facing elementary teachers.

At the college level the faculty of biological sciences must become more aware of existing problems and conditions and take steps to correct present conditions which do not lead to the desired goals and objectives of an introductory science course. A study of present general biology courses must be made before changes can be initiated. Once the curriculum patterns are revealed then the way in which these courses strengthen the training of elementary teachers may be ascertained.

Importance of the Study

Additional research in the area of course content and methodology in the beginning biology course is needed for at least three reasons. First, if general biology is a required course in the general education program in the state of Oklahoma then as a required course it plays an important role early in the student's training in formulating opinions and attitudes toward science. The second reason is that information concerning recent curriculum content in introductory biology courses in Oklahoma has not been analyzed. The third reason is previous studies in Oklahoma have not attempted to describe a college biology course with respect to course content and methodology and the way this is related to the training of elementary teachers.

It is not the intention of this study to reveal weaknesses in general biology courses. Rather, agreement among the respondents will reveal a pattern which will help educators plan a more effective pre-service program for elementary teachers. Science in the elementary schools has been completely changed while many science courses at the college level have changed little if at all. Studies such as the present one may reveal a need to design science courses for prospective elementary teachers to provide them with an opportunity to study science in the same way that they are expected to teach science.

CHAPTER II

SELECTED REVIEW OF THE LITERATURE

Science curriculum revisions began at the secondary school level over a decade ago when educators realized that science courses must differ in emphasis, purpose and kind from that of the preatomic and premissile eras (38). The science education revolution began with the notion that science is more than a collection of facts obtained by memorization; science is knowing something about the character of scientific knowledge, how it is used, how it was developed. Grobman (30) reports that biology is taught in our schools today as if no science instruction occurred before the tenth grade. However, some educators have been working for a continuously articulated science program from kindergarten through high school and new science programs have been introduced in the elementary school. (41)

Revised elementary science curriculum placed a demand on the elementary teacher to achieve newly established science education goals. In many instances the inadequate preparation of the elementary teachers resulted in reluctance on their part to teach science (35) (80). Simmons (76) points out that teachers who had difficulty learning science concepts would not be interested in trying to teach these same science concepts to children.

Curriculum revision has come slowly to college science. However, there are some innovative programs in biology such as those at Mankato

State College (45), Ball State University (56) and Purdue University (60). A scientist and educator group has been formed, the Commission on Undergraduate Education in the Biological Sciences (CUEBS), but there has been no major revision of the curriculum with structured programs of prepared material like that found on the elementary and secondary level (31).

Prospective elementary teachers should be prepared to teach new programs in science that are being developed; they should be prepared to continue their study of science after graduation to adjust to a changing curriculum. They should study science in college in the same manner as they are expected to teach it (34). To define what is expected of elementary teachers and to direct curriculum improvement, the AAAS Commission of Science Education established guidelines and standards for the preservice education of elementary teachers in February, 1969 (64).

This issued a challenge to college curriculum developers to include the suggested science education goals within the structure of revised college general biology curriculum. The elementary teacher should be liberally educated but studies are needed to determine ways in which preservice science education might be improved to meet the demands for more effective science teaching in elementary schools. Scientists who teach science courses containing sizable numbers of prospective elementary teachers should ask such questions as:

> Are the science experiences that will be most valuable for future elementary teachers the same as those for future lawyers? If not, what experiences do teachers need? What must the future elementary teacher know about the problems in environmental science, population studies, genetics and evolution? (64)

Science Education in Transition

The literature indicates that most science educators are in agreement that better use must be made of advances in areas such as psychology, sociology and technology if the problem of the most effective approach to the teaching of science is to be resolved. Gagne (26) reports that if science education is to begin at the earliest elementary level one must have a rationale that connects adult behavior with child behavior. Balzer (2) proposed that the organization of content and learning experiences must integrate considerations such as: child development, interest, logical structure of disciplines, attitude development, the nature of learning, facilities, social context and teacher preparation.

Various teaching procedures have been proposed. According to Shulman (74), Bruner of Harvard University is without a doubt the one person most closely identified with the 'learning by discovery' method that has become so popular among curriculum reformers. Bruner (9) maintains that rarely is something discovered outside the learner. Rather, discovery is the act of reorganizing previously learned facts to produce a better fit between these facts and the regularity with which they will be encountered in the learner's experience.

Raven (65) reports that major concepts of a subject should be determined and then a hierarchy of concepts from simple to complex be sequenced to enhance the learning of the key concepts. These major concepts and the relationship among them would provide the structure for the course. Postlethwait (62) suggests that traditional structure should be discarded as a starting point for curriculum revision and a solution based on a definition of objectives be sought. The fundamental guideline which he stresses is that learning is an activity done by an individual and not something done to an individual. Kurtz (46) advocates the non-content oriented approach to teaching developed along behavioral objectives. He proposes a key question be asked: What do I want my students to do after taking my course that they couldn't do before enrolling in it?

There is a growing popularity of behavioral objectives at the elementary and secondary levels as well as in colleges and universities. The college faculty, however, hold different opinions concerning the usefulness of behavioral objectives in higher education. Ericksen (24) states that:

> Clear-cut behavioral objectives are difficult to define for most college-level courses. How . . . can the instruction and evaluation be adjusted to encompass the subtle objectives of motivation to learn, critical thinking, value judgment, favorable attitudes toward the discipline, ability to organize relevant information and to solve problems, etc.?

Another style of teaching which has received much attention during the past decade is the inquiry approach. Burns and Ellis (10) report that inquiry techniques are clearly related to discovery learning but are not necessarily synonomous. Suchman (77) states that inquiry is wide open, whereas in discovery, controlled procedures lead to predicted results. In teaching by inquiry the teacher encourages and aids the child in discovering hidden concepts (18). Gagne (25) reports that there is wide spread agreement among educators and scientists that inquiry should be woven into the curriculum program to form a learning pattern. He further reports that the idea of inquiry is perhaps, the most essential objective of science instruction. Lee (50) is uncertain whether science teachers, and even some scientists, really know the meaning of inquiry, much less incorporate it into their teaching. He reports that many college science faculty practice inquiry in the laboratory but do not or can not make use of it in classroom instruction.

To facilitate the use of objectives in education, Bloom (5) developed a taxonomy of educational objectives as a standard classification for the exchange of information about curriculum developments and the evaluation of the resulting programs. The hierarchical order of the taxonomy helps specify objectives so it becomes easier to plan learning experiences. The taxonomy is divided into two domains: the cognitive and the affective. Frequent reference to the various classification of objectives has made the approach to curriculum development more uniform.

Elementary School Biology

In the early 1960's elementary science became such a major concern it received national attention and marked the beginning of a period to seriously reconsider the entire elementary science curriculum (38). The vastness of the fields of modern science required a variety of specialists to produce effective new courses, consequently study groups were formed and the development of elementary science projects began. Victor (81) states the movement to reform elementary science may be related to three basic causes:

1. The unprecedented explosion of science knowledge.
2. A marked interest in science education.
3. The new curriculum developments for high school and junior high school science.

What makes the 'new' science different from the textbook science? The difference is due in part to a changing science education philosophy that the curriculum should present science as the scientists see science and in terms of modern concepts and theories (40). Wyatt and Atkin (84) believe that the time to begin the study of science is in the elementary grades because the child has a high curiosity and excitement about the natural universe and it is at this time that these characteristics should be nurtured. Curiosity appears to come naturally and inseparably with the child in the first year of school. It may be fostered by intellectual freedom in the classroom and spurred by interesting systems to investigate (72). Walcott (83) maintains that elementary school biology must begin with the child's interest and concern and lead him to a greater understanding of the living world.

Hopman (37) asserts that new experience, new questions and new answers characterize a science that is changing and dynamic. Knowledge in science undergoes continuous revisions; curriculum likewise must undergo constant change. Renner and Ragan (67) state there are certain major mental processes which every practicing scientists goes through sometime during any investigation. They further state that experience with and the acquisition and understanding of these processes by children represent the major educational values to be derived from the study of science. Suchman (77) supports an inquiry approach to the teaching of science to children because it helps children see that in creating knowledge, man is constructing order out of chaos. Gagne (27) suggests a concentration on the process of science in the elementary grades and that the systematic content learning begin in the seventh grade. Redfield (66) believes it is important for the student to acquire knowledge through involvement as a scientist.

Some curriculum projects which were developed in support of these ideas are: The AAAS Process Approach supported by the American Association for the Advancement of Science; The Elementary Science Study (ESS) conducted by Educational Services Incorporated; The Science Curriculum Improvement Study (SCIS) undertaken at the University of California at Berkley; The Minnesota Mathematics and Science Teaching Project (MINNEMAST) at the University of Minnesota; The Conceptually Oriented Program in Elementary Science (COPES) developed at New York University (81). ISCS is the Intermediate Science Curriculum Study undertaken at Florida State University and is an effort to articulate elementary and secondary science programs (66).

Kurtz (47) points out in discussing the AAAS approach that children learn how to do what scientists do and are evaluated in terms of behavioral changes. He states that features crucial to understanding the place of biology in the AAAS program are:

1. Published materials are for teachers; there are no texts for children.

2. The instructional objectives are precise descriptions of behaviors the child is to demonstrate at the completion of each exercise.

3. The behavioral objectives are grouped into fourteen processes of science: observing, classifying, measuring, communicating, using space-time relations, using numbers, predicting, inferring, formulating hypotheses, controlling variables, defining operationally, interpreting data, experimenting, and formulating models.

4. The behavioral objectives comprising each process are arranged in a hierarchy and each objective in this sequence requires the learning of the previous behaviors.

Cunningham (19) reports that science instruction in the ESS program is developed around three phases. The first phase is a 'messing about' phase where the children have fun. Eventually the way of 'messing about' becomes a way of work although the childlike curiosity is not lost. The second phase is a 'multiple programmed' phase where various audiovisual aids are used to foster further explorations. The final phase involves discussion, lecturing, arguing, theorizing, etc., that don't occur to children during the earlier phases.

Thomson and Voelker (79) refer to the SCIS approach as the direct approach to learning, where the child is the inventor, communicator, evaluator and synthesizer while the teacher is the catalyst, guide, observer and evaluator. Lawson (49) presented one scheme of the SCIS program as starting with whatever ideas the children had concerning life and builds from there, using the childrens' own observations as a foundation for the development of biological concepts. Central to the SCIS program is the idea that extensive laboratory experiences during the elementary school years will enable the child to relate scientific concepts to the real world in a meaningful way (71). The SCIS program is built around four major concepts: matter, energy, organisms and ecosystems. The way in which these four concepts are dependent upon one another give depth to the interaction concept (72).

Cummingham (19) summarizes the philosophy underlying some of the new elementary science curriculum in the following way:

> Some projects aim to introduce the child to certain intellectual 'inventions' found useful by man in his history for interpreting natural phenomena (e.g., SCIS, MINNEMAST) while others do the same for man's useful 'processes' of investigating the world (e.g., AAAS). Still others are developing investigations into biological phenomena that are more open-ended and that include both of the above elements (e.g., ESS).

New Demands of Elementary Teachers

Current elementary science curricula makes new demands of elementary teachers. Many elementary teachers realize they do not have an adequate science background (80). Some have found the teacher's handbooks and curriculum guides highly ineffective in providing them with needed help to succeed in teaching elementary science as designed by curriculum committees. Others were deceived by some of the highly structured exercises of the new curriculum projects and falsely assumed a science background was not necessary to teach science (81).

What do elementary teachers need to know to be effective elementary science teachers? What could be done to improve the college curriculum for the prospective elementary teacher so the undergraduate training they are now receiving will better prepare them for the innovative projects now found in the elementary grades? Some suggestions have been made. Ginsburg (28) reports that persons preparing for elementary school teaching should have 'in-depth' preparation in science and should be given the opportunity to examine and correlate what they learn in college with what they will be expected to teach (45). He also believes their preparation in science should involve developing such mathematical skills as statistics and probability.

Koran (44) maintains the elementary science teacher should be familiar with the essential characteristics of concept formation. The knowledge of concept formation enables an individual to generalize as well as discriminate. It is essential to good biology teaching that the biological concepts to be presented are determined prior to instruction.

One method of teaching often associated with some of the new programs is the inquiry method. What are the characteristics a teacher of inquiry should have? Postman and Weingartner (63) list the traits which distinquishes this teacher as follows:

1. The teacher rarely tells students what he thinks they ought to know.

2. His basic mode of discourse with students is questioning.

3. He usually does not accept a single statement as an answer to a question.

4. Student-student interaction is encouraged; student-teacher interaction is opposed.

5. He rarely summarizes the positions taken on the learnings that occur.

6. His lessons develop from the responses of students and not from a previously determined 'logical' structure.

7. Generally, each of his lessons poses a problem for students.

8. He measures his success in terms of behavioral changes in students.

Teaching science through discovery; teaching science by inquiry; teaching science as a process--the properly prepared elementary teacher must meet any of these new demands for a creative, stimulating way of teaching. It is Kessen (43) who catches the spirit of the new science education philosophy when he proclaims:

> The child can understand only what he has been prepared to understand, the teacher can teach only what he knows, and the meeting of the prepared child with skillful teacher is an unforgettable encounter for them both.

The Need for College Biology Curriculum Revision

Students in today's college classrooms are restless and bored (4). The underlying reasons are no doubt many; however, an effort should be made to determine to what extent, if any, the curriculum contributes to the general restlessness (1). What do students expect of their undergraduate education in general and biology in particular? Is there a need to reform the college general biology curriculum?

College biology faculty recognize that the biology curriculum must be reformed (56). This may be based on the knowledge explosion (62), a shift in emphasis (33), pressure from students or curriculum revisions at other educational levels. Mayer (52) states that a critical re-examination of the discipline is needed in terms of its philosophy, content and methodology.

Hankins (32) alleges that a critical problem existing in colleges and universities today is the quality of teaching in introductory biology courses. She accuses the Ph.D.'s as scholars of devoting most of their time to research and readily abandoning teaching. This argument is supported by Dunham (23) in his study of the colleges and developing universities in America.

Hutto (42) critizes the college faculty for structuring their biology courses around adopted textbooks. There is a great variety of texts; from the simple to the complex; from cell emphasis to ecological emphasis. As a result, the course changes as the textbook changes without considering the needs of the student. What seems to be needed in the curriculum effort to revise the biology curriculum is organization and direction.

Dean (20) maintains that a weak point of many introductory biology courses is the 'cook book' approach to laboratory instruction. Hutto (42) asserts that there are too many demonstrations and dissections and too few opportunities for students to participate in true scientific investigation. A study conducted by Butts (11) revealed designed experiences are needed to train teachers to substitute search for basic principles instead of fact memorization.

Boulos (8) supports the idea that isolated facts are over emphasized and that:

> Knowledge gained is . . . of a fragmentary nature with attention focused on facts . . . which may . . . be forgotten . . . or become obsolete by the time the student becomes a teacher.

He continues that prospective teachers often gain knowledge in fields which have little value to them. The colleges which train them have given little thought to courses designed to enhance the teacher education program. He suggests that college science faculty that have large numbers of prospective elementary teachers in class, keep in mind that an elementary teacher is more of a 'general practitioner' than a specialist'.

How should the course content be presented? Should the popular science survey be continued and perhaps extended? Or should there be a shift toward fewer topics and perhaps a different methodology? Dean (21) presents two major faults with science surveys:

> 1. A survey of the content of a science . . . often fails to convey the true nature of science . . . science as quest.
>
> 2. Only by much effort and compromise can the indispensable content of a discipline be identified.

He questions whether a student really ends such a course with a better understanding of the role of imagination in scientific discovery.

In the selection of course topics Scherba (70) reports that ideas should be chosen that contributes significantly to the understanding of basic biological principles. Laetsch (48) makes the accusation that college biology faculty have done and are doing very little to increase the students' awareness of the role biology must play in understanding today's world problems. There has been an expressed need among college biology faculty to select science content for introductory courses which will reveal to the student the vast scope of biology while at the same time making him aware of the investigative nature of biology (15).

Olson (60) presents a rationale for establishing a separate course for future elementary school teachers; these students could well be the most important student in any college general biology class. He states the special course should not be a methods course but one that differs more in attitudes than in content. He stresses the course should have well defined behavioral objectives in harmony with present views of what an elementary science teacher should be.

Restructuring the Biology Curriculum

It is not enough in this present age to teach concepts, generalizations and science theories. In addition an attempt should be made to make the student aware of attitudes, decisions, strengths and limitations, and values embodied in biology (54). This is particularly true if the basic philosophy of the course is that it msut be useful to the student.

A person in curriculum design needs a concrete idea of his special field and to consider alternate solutions. Roos (68) lists several plans which may be followed in restructuring an introductory biology course. These plans are:

1. A survey of the entire body of facts understood to be included within the discipline and to create a set of predictive general concepts.

2. An introduction to subjects in selected 'core' areas that will be further developed in advanced courses. (58)

3. An examination in depth of limited portions of the total subject area. (58)

4. A discussion of a set of concepts common throughout the discipline or necessary to its further study.

What topics should make up the course content of a general education biology course? Walbesser (82) states that topics can be chosen by selecting from content domains as related to the following questions:

1. What big ideas from this discipline should be chosen?

2. What particular topics are fundamental to an understanding of the discipline?

3. What particular facts must an individual know if he is to appreciate the significance of this discipline?

Hurd (40) believes that course content should have priorities that are consistent with modern science as well as the goals of science teaching. He states the course content should provide a logical and integrated picture of contemporary science; illustrate the diverse processes used in science and "enable the student to reach at some point the shadow of the frontier".

A list of topics was prepared by CUEBS by analyzing responses obtained by letters sent to 110 persons in the biological sciences and related fields (15). The list of topics is as follows:

1. The history of life.

2. Natural variation.

3. The nature of genetic continuity.

4. Molecular nature of life processes.

5. Biological holism and reductionism.

6. Homeostasis at all levels.

7. Environment-organism interactions.

8. Biological basis for behavior.

9. The species concept.

10. Dynamics of biological populations and ecosystems.

12. Human population problems.

13. Conservation of natural resources.

14. The nature of man.

15. Sound attitudes toward public health and medicine.

Shamos (73) states that introductory biology is open to most students with no distinction made between science majors and nonscience majors. Some believe the best way to develop appreciation for a scientific discipline is for equal treatment of the major and nonmajor. Others expressed the fear that a course for nonmajors may become a watered down version of the course offered to majors (32). A majority of scientists and educators, however, accept the idea of separate classes for the two groups (15).

Even though there is a swing toward the teaching of science as inquiry in college biology classes there is evidence that the lecture method is still the most popular and perhaps, most successful; especially for large introductory classes. Bell (3) investigated alternate methods for teaching large sections of general biology and found that a variety of instructional methods and instructional techniques had no apparent effect on the student's achievement and attitude.

Should a laboratory be part of an introductory biology course? Most science faculty indicated it should be included; however, there is obvious distaste for the usual type of laboratory exercises which is so often a part of the college introductory course (15). Novak (57) reports that scientific inquiry can best be introduced, developed and practiced in the laboratory. He goes on to state that the inquiry laboratory is student centered, student activated and completely unstructured.

A panel on the laboratory in biology formed by CUEBS was charged with clarifying the function of the laboratory in the changing biology curriculum (17) (36). The objectives they formulated for laboratory instruction are:

1. To illustrate objects and experiments that have been introduced elsewhere.

2. Provide training in laboratory techniques.

3. To intellectually stimulate the student and develop an appreciation for biology and for living things.

4. To stimulate discussion.

5. To engage the student in the process of investigation.

Shamos (73) contends that many academic scientists not only believe the laboratory is an important part of science education but that special attention should be directed to course design and laboratory experience for nonscience students. Elementary teachers are a group of nonscientists that could well profit from such a laboratory. Kuhn (45) reports that to accomplish objectives which new courses define, appropriate types of undergraduate programs in biology must be instituted. An appropriate course would have a major emphasis on laboratory with frequent reference to laboratory activities in the existing elementary science curricula.

Poslethwait (62) presented the idea that people differ in receptivity to different approaches to a subject. Furthermore, some people may learn and respond best through an audio approach, others a video approach, and others a mechanical approach. This suggests a multiplicity of approaches. The audio-tutorial is one method that is currently being used to individualize instruction. The use of the newly developed teaching module is another way of accomplishing this (16). The modular approach may help to bring about needed changes in curriculum structure. Modules can be used to help the student master skills, change attitudes and learn concepts; they may even be inserted into the traditional type course.

Blough (6) states evaluation is an important part of the teaching-learning relationship. He reports the evaluation process reveals the degree of success in achieving the course objectives and of methods being used by the teacher and learner in moving toward these goals. Evaluation is a continuing process which is inherent in specified course goals and objectives. Ericksen (24) states that evaluation is a sensitive and delicate topic. Students do not object so much to hard work as they do to unfair treatment. The grading system is criticized by Ericksen when it is used as a universal indices to academic proficiency.

Summary

The changing science curriculum of the 1960's was an attempt to solve some major problems in science education but other problems were created as a result. One problem which faced the elementary teachers of science was the demand to teach the new science in a way which was unfamiliar to them. Elementary science instruction moved from facts in the books into the uncertain realm of inquiry, discovery or process. Furthermore elementary teachers could see little relationship between the science topics they were expected to teach and the science topics they were taught in their college science courses. Guidelines and standards for the preservice training of the elementary science were established by national science educators in February, 1969. This group searched for commonalities among the new science programs which should be included in any teacher preparation program. Since the way a teacher approaches his own teaching functions is a reflection of the way he was taught there is a definite need to revise the college biology curriculum to reflect the new philosophy and aims of science education. The literature reveals an expressed urgency for college biology curriculum revision to move into line with the rapidly developing programs on the elementary and secondary levels. There is much disagreement as to whether this should be done; how this should be done; and who should be responsible for the change.

CHAPTER III

METHODS AND PROCEDURES

Evidence has been presented which indicates the proliferation of scientific knowledge has produced too many facts for the student to absorb. Thus, it is becoming important to select the basic concepts which scientists feel are most important to stimulate scientific thought which will serve the student tomorrow as well as today. Once these are selected they should be used at all levels of learning; by majors as well as nonmajors.

A review of the literature produced enough evidence, in the opinion of the writer, to investigate the college general biology courses in Oklahoma's institutions of higher education as well as investigate the science background and attitudes of elementary teachers which have graduated from Oklahoma's colleges and universities. The results obtained would provide a baseline for the development of a general biology course for majors and nonmajors alike; particular attention given to fulfilling the special needs of elementary teachers as presented in the previous chapter. The review furnished information concerning the factors of curriculum development that should be included in the present study. The investigator realized that it was impossible to study all factors in depth. Some factors were studied in greater detail than others depending upon the relative importance as gathered from the literature.

Design of the Study

The present study is a descriptive survey which gathered opinions from college biology faculty and elementary teachers concerning the introductory college biology course. The results obtained from descriptive surveys are preliminary to a later, more detailed investigation (7).

The following steps were followed in the development and completion of the dissertation:

1. The major research of the literature was confined to developments since 1960. It was after 1960 that new elementary science curriculum programs began rapidly developing.
2. The literature was reviewed in areas relating to introductory college biology course content and methodology and in areas of competencies desired of elementary teachers as defined by national science educators. These areas served as a basis for determining the selected statements included on the opinionnaire.
3. A 79 statement instrument was developed. The general areas selected to be studied were:

   A. Course Content

   B. Methodology

   C. Individual Study

   D. Laboratory

   Additional areas also considered were:

   E. Methods of Evaluation

   F. Behavioral Objectives

   G. Major and Nonmajor Science Students

H. Research and its Effect on Teaching

4. The opinionnaires were sent to a selected group of college biology faculty in Oklahoma's institutions of higher education. The biology faculty were chosen from the faculty directory of the Oklahoma Association of Undergraduate Education in Biology (OAUEB). The elementary teachers were selected from graduates of Oklahoma's institutions of higher education. This list was obtained from the Oklahoma State Department of Education.
5. The data obtained from the opinionnaires returned by the college faculty and elementary teachers were analyzed by means of graphs, mean rank responses and percentage response in each rank category. Extent of agreement between the two groups was determined by the Pearson product moment correlation coefficient. (61)(69)
6. A curriculum outline for a college general biology course was developed based on the results of the study.

Definition of Terms

The following terms are defined:

Science education goals: general statements about the purpose of science instruction. The major ends sought--the over-all directions.

Science objectives: specific statements about the purpose of science instruction which can change depending upon society, students and current problems.

Behavioral objectives: specific statements concerning student activities directed toward the achievement of course goals and objectives; evaluated in terms of observable student behavior (24). Precise descriptions of behaviors the student is to demonstrate at the completion of each exercise (47).

Curriculum: all experiences that the institution provides to assist the student in acquiring competencies needed to obtain the goals and objectives of the educational institution and the subject matter course (64).

Curriculum core: represents the major concepts, techniques and conclusions of biology and exemplifies their interrelations (28).

Content: fundamental facts, concepts and principles of the subject matter.

Structure of a discipline: the central ideas of a science and the relationship among these ideas (65).

Scientific fact: a discrete scientific unit or idea (44).

Concept: a category of knowledge that permits a person to generalize over a large group of objects and events, to discriminate between objects and events, and to assimilate previously unencountered objects and events under the formerly acquired categories (44).

Processes of science: fundamental intellectual skills necessary for the pursuit of scientific knowledge. A general class of activities being undertaken with respect to forms of information processing. Process words are such words as classifying, measuring and hypothesizing and represents in formal terms the activities the student carries out in pursuing scientific knowledge (27).

Inquiry: a set of activities directed toward solving an open number of related problems in which the student has as his principle focus a productive enterprise leading to increased understanding and application (51). Inquiry is wide open and suitable to areas of why and <u>how</u> (77). An accepted model of behavior during instruction (13).

<u>Discovery</u>: controlled procedures which lead to predecided results.

Development of the Instrument

The most practical instrument for obtaining information from a large sample is the opinionnaire (29). The rank order scale has been a successful opinion gathering technique. This technique is especially useful when the investigator cannot personally contact the people he has selected as respondents in his study. The rank order scale, which is a type of check list, is an accepted method in educational research as a way to obtain uniform, rapid responses; it also aids in the collection and treatment of large quantities of data (7).

An opinionnaire, consisting of 79 statements, was prepared for the college biology faculty. A rank order scale was used for 75 of the questions. The first 40 questions used a scale which moved from one end to the other as follows: very strong emphasis, strong emphasis, medium emphasis, weak emphasis, very weak emphasis. The next 35 questions used a different rank order scale as follows: strongly agree, agree, undecided, disagree, strongly disagree. The remaining statements required the respondents to select appropriate responses as directed by the opinionnaire. The opinionnaire also provided for obtaining additional information such as the teacher's age, teaching experience, sex, type of institution where they teach, level of academic training, class size, and the type of institution where they took their general biology course.

A parallel form of the opinionnaire with an identical rank order scale as described for the college biology faculty was prepared for elementary teachers. Each numbered question corresponded to the same numbered question on the college biology faculty's opinionnaire. The questions 1 through 40 on the elementary teacher's opinionnaire were reworded to make the meaning clearer to the elementary teacher, but the content of the questions remained unchanged. Questions 41 through 75 on both opinionnaires were identical. The remaining question (77 through 80) required the respondents to select appropriate responses as directed by the opinionnaire.

A preliminary form of the opinionnaire was administered to a jury group of eight elementary teachers enrolled in Education 532, Science for the Elementary teacher, at Central State University. These individuals were asked to answer the opinionnaire and indicate areas of difficulty or weakness. The critique of the opinionnaires obtained from each individual resulted in a final revision.

Certain limitations in the method of using the opinionnaire is recognized by the investigator. Some limitations are as follows: statements, omission of some pertinent statements, length, ambiguous directions. The opinionnaires are displayed in Appendix B.

Selection of the Sample

Two populations were selected to be investigated--the college biology faculty and elementary teachers.

The college biology faculty: this group is defined as bing currently engaged in teaching at least one college general biology class. The study was limited to Oklahoma's institutions of higher education. The institutions included four different types: the university, the state college, the liberal arts college, and the junior college. A list of Oklahoma's college and university biology faculty was obtained from The Oklahoma Association For Undergraduate Education in Biology (59).

The elementary teachers: this group is defined as being graduates of Oklahoma's institutions of higher education. By restricting the study to this group the curriculum revision which the study might indicate is needed would be more closely related to the strengths and weaknesses of the college biology curriculum in Oklahoma.

An IBM listing of elementary teachers was obtained from the Instruction Division of the State Department of Education (53). It was desired to keep the number in both groups the same; so from the IBM list a random sample of one hundred elementary teachers was chosen. The addresses of the elementary teachers were obtained from the Teacher Certification Section of the State Department of Education (12).

Procedure for the Distribution and Return of the Instrument

The opinionnaires were mailed to each biology faculty member who taught at least one general biology course in Oklahoma's institutions of higher education. An opinionnaire was mailed to each elementary teacher selected as part of a random sample as indicated earlier in this chapter. All opinionnaires sent included a self-addressed and stamped envelope. Each opinionnaire was accompanied by a cover letter explaining the importance of the study. The opinionnaires were number coded so a follow-up letter could be sent to those educators not responding (29).

Description of the Respondents of the Population

Seventy eight members of the college biology faculty responded or 78 per cent of the population. The elementary teachers who returned completed opinionnaires represented 63 per cent of the population. Another 13 opinionnaires were returned with an explanation of why the opinionnaire could not be completed. The explanations ranged from a feeling of inadequacy in science to the fact that they were specialists in some other area of elementary education. The total response from elementary teachers was 75 per cent.

The background of the college biology faculty as determined from an analysis of the personal data collected on the population revealed that nine per cent had some elementary teaching experience and 44 per cent had some secondary teaching experience. Those who had taught at the college level for less than five years made up 51 per cent of the population with 14 per cent teaching for more than 16 years. The portion of the population who had taught the college general biology course for one to three years was 29 per cent and 24 per cent had taught the course for four to six years. Six per cent had been teaching the course for 20 years or more. The average age was 35 years and 88 per cent of the population were males. The respondents located in universities made up 36 per cent of the population, 35 per cent were from state colleges and 16 per cent from junior colleges. A level of training analysis showed 6 per cent had the Doctor of Education degree, 41 per cent had the master's degree and 51 per cent had the Doctor of Philosophy degree.

The background of the elementary teachers as determined from an analysis of the personal data collected on the population showed that at the kindergarten through the third grade level 34 per cent of the teachers had taught for less than five years with 19 per cent having 16 years or more experience. At the intermediate level 26 per cent of the respondents had been teaching for less than five years and 16 per cent had been teaching at this level for over 16 years. Those with experience in secondary school teaching represented 16 per cent of the sample and 1.6 per cent had some college teaching experience. The average age of the elementary teachers was 38 years and 87 per cent of the population were females. A level of training analysis showed that 60 per cent had a Bachelor's degree, 36 per cent had a Master's degree, 1.6 had the Doctor of Education degree and 1.6 had the Doctor of Philosophy degree; 1.8 per cent did not respond.

Treatment of the Data

The percentage of responses to each rank order scale for opinionnaire statements from 1 to 75 for both groups--the college biology faculty and elementary teachers--were placed on the same graph for easy comparison. This allows a rapid scanning as well as a detailed analysis of the responses as desired by the reader. The percentage is given at the end of each horizontal bar for rapid interpretation. The graphs are in Appendix C.

Tables were used for the tabulation of the mean rank responses to opinionnaire statements. Tables were also used for the tabulation of percentage response for those opinionnaire statements not having a rank order scale. Pearson's r was used to determine the extent of agreement between the two groups studied. (75)

CHAPTER IV

THE RESULTS

Data obtained from the descriptive survey of opinions concerning Oklahoma's college general biology curriculum are included in this chapter. Responses to an opinionnaire from two populations are analyzed; the two populations are the college biology faculty and the elementary teachers. Seventy eight college biology instructor respondents are compared with sixty two elementary teacher respondents. The two opinionnaires are in Appendix B.

Interpretation of Data

The results from the first 75 statements on the opinionnaire are presented in the form of graphs and tables. A detailed analysis of responses to each opinionnaire statement is given in the form of graphs. The graphs are displayed in Appendix C. Table I shows the response of the two groups to the course content portion of the opinionnaire. The table presents the data in order of increasing mean rank of the college faculty. A rank of 1 indicates very strong emphasis and a rank of 5 is very weak emphasis. Thus, the Opinionnaire statements are arranged in order of those topics which should receive the greatest emphasis in a general biology course as determined by the college biology faculty.

TABLE I

RESPONSES TO COURSE CONTENT STATEMENTS OF THE COLLEGE BIOLOGY FACULTY AND ELEMENTARY TEACHERS IN ORDER OF INCREASING MEAN RANK OF THE COLLEGE FACULTY

Opinionnaire Statement	CBF* (mean rank)	ET** (mean rank)	DIFFERENCE IN MEAN RANK
The living world is made of ecosystems.	1.73	2.87	1.14
Energy has a unidirectional flow through ecosystems.	1.76	2.63	.87
Man is a powerful ecological force.	1.79	2.08	.29
The earth has finite space, material and available energy.	1.90	2.19	.29
Life processes are common to all living organisms.	1.92	2.39	.47
Cell functions provide basic information about life functions at all biological levels.	1.95	2.47	.52
All living systems are actively engaged in maintaining homeostasis.	1.99	3.08	1.09
Organisms reproduce themselves by sexual and asexual methods.	2.01	2.74	.73
The basis of heredity is the reproduction and transmission of DNA and RNA.	2.04	2.87	.83
The gene consists of DNA and is the fundamental unit of heredity.	2.10	2.65	.55

TABLE I (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Order is a constant theme in biology.	2.12	2.63	.51
Four groups of organic compounds form the basis of all living components.	2.15	2.60	.45
Population growth is related to reproduction and migration.	2.15	2.73	.58
Activities of living organisms result from chemical and physical processes.	2.24	3.11	.87
Change is a natural phenomenon: all things change through time.	2.24	2.65	.41
The universal genetic code is based on four different nucleotides.	2.26	3.42	1.16
Genetic material determines the properties of living organisms.	2.32	3.40	1.08
Some life processes are shared by all higher animals.	2.33	2.19	.14
Feedback systems help regulate the activities of living systems.	2.33	3.13	.80
Living systems have four basic attributes.	2.37	2.18	.19
Photosynthesis results in the storage of energy in chemical bonds.	2.37	2.45	.08

TABLE I (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Adaptation has resulted in biological organization.	2.37	2.66	.29
Plant and animal pests can best be controlled by natural means.	2.44	2.53	.09
The development of an organism results from an interaction with its environment.	2.45	2.74	.29
Biological patterns of diversity are the results of evolution.	2.45	3.52	1.07
Complex living systesm are controlled in part by enzymes.	2.46	2.66	.20
One cell organisms perform all the basic functions of life.	2.50	2.73	.23
There are certain basic life processes shared by all higher plants.	2.50	2.15	.35
Mutations in a population are random; selection of mutations form patterns.	2.53	3.32	.79
Man's social interaction has a basic biological behavioral pattern.	2.59	2.71	.12
Cellular respiration provides energy in a form usable by all cells.	2.62	2.69	.07
Most microorganisms are essential components of the ecosystem.	2.67	2.73	.06

TABLE I (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Animal behavior has evolved just as other biological processes have.	2.68	2.84	.16
The basis of classification is formed by hereditary differences.	2.69	2.60	.09
The animal kingdom can be sub-divided into vertebrates and invertebrates.	2.71	2.71	.00
No single characteristic separates plants from animals.	2.74	3.32	.58
Diseases are ideally controlled by prevention rather than cure.	2.77	2.18	.59
As a zygote develops it loses part of its ability to differentiate.	2.78	3.05	.27
There are two groups of plants important to man: the Gymnosperms and Angiosperms.	3.01	2.58	.43
Life may have begun spontaneously in a primitive environment.	3.05	3.53	.48

*CBF College Biology Faculty

**ET Elementary Teachers

Table II compares the difference in mean rank between the two groups. The statements with which both groups of respondents most closely agree are given first. The last statements on the table reveal the areas of greatest disagreement.

TABLE II

RESPONSES TO COURSE CONTENT STATEMENTS OF THE COLLEGE FACULTY AND ELEMENTARY TEACHERS LISTED IN ORDER OF DIFFERENCE IN MEAN RANK

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
The animal kingdom can be sub-divided into vertebrates and invertebrates.	2.71	2.71	.00
The basis of classification is formed by hereditary differences.	2.69	2.60	.03
Most microorganisms are essential components of the ecosystem.	2.67	2.73	.06
Cellular respiration provides energy in a form usuable by all cells.	2.62	2.69	.07
Photosynthesis results in the storage of energy in chemical bonds.	2.37	.245	.08
Plant and animal pests can best be controlled by natural means.	2.44	2.53	.09
Man's social interaction has a basic biological behavioral pattern.	2.59	2.71	.12
Some life processes are shared by all higher animals.	2.33	2.19	.14

TABLE II (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Animal behavior has evolved just as other biological processes have.	2.68	2.84	.16
Living systems have four basic attributes.	2.37	2.18	.19
Unicellular organisms perform all the basic functions of life.	2.50	2.73	.23
As a zygote develops it loses part of its ability to differentiate.	2.78	3.05	.27
The development of an organism results from an interaction with its environment.	2.45	2.74	.29
The earth has finite space, material and available energy.	1.90	2.19	.29
Man is a powerful ecological force.	1.79	2.08	.29
Adaptation has resulted in biological organization.	2.37	2.66	.29
There are certain basic life processes shared by all higher plants.	2.50	2.15	.35
Change is a natural phenomenon.	2.24	2.65	.41
There are two groups of plants important to man.	3.01	2.58	.43
Four groups of organic compounds form the basis of all living components.	2.15	2.60	.45

TABLE II (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Some life processes are common to all living organisms.	1.92	2.39	.47
Life may have begun spontaneously in a primitive environment.	3.05	3.53	.48
Order is a constant theme in biology.	2.12	2.63	.51
Cell functions provide basic information about all life functions.	1.95	2.60	.52
The fundamental unit of heredity is the gene.	2.10	2.65	.55
Population growth is related to reproduction and migration.	2.15	2.73	.58
No single characteristic separates plants from animals.	2.74	3.32	.58
Diseases are ideally controlled by prevention.	2.77	2.18	.59
Organisms reproduce themselves by two different methods.	2.01	2.74	.73
Mutation in a population is random.	2.53	3.32	.79
Feedback systems is one method which regulates the activities of organisms.	2.33	3.13	.80

TABLE II (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
The phenomenon of heredity in all living things is the reproduction and transmission of DNA & RNA.	2.04	2.87	.83
Energy has a unidirectional flow through ecosystems.	1.76	2.63	.87
The activities of living organisms result from chemical and physical processes.	2.24	3.11	.87
Complex living systems are controlled in part by enzymes.	2.46	3.48	1.02
The biological patterns of diversity are the result of evolution.	2.45	3.52	1.07
DNA is decoded by RNA.	2.32	3.40	1.08
All living systems are actively engaged in maintaining homeostasis.	1.99	3.08	1.09
The living world is made of ecosystems.	1.73	2.87	1.14
The universal genetic code is based on various combinations of four different nucleotides.	2.26	3.42	1.16

Table III presents the responses of the two groups to the methodology and philosophy section of the opinionnaire. The table gives the data in order of increasing mean rank of the college biology faculty. The scale rank of this part of the opinionnaire is as follows: (1) strongly agree, (2) agree, (3) undecided, (4) disagree, (5) strongly disagree. This table lists the statements in order of strongest agreement to strongest disagreement as determined from college biology respondents.

TABLE III

RESPONSES TO METHODOLOGY STATEMENTS OF THE COLLEGE BIOLOGY FACULTY AND ELEMENTARY TEACHERS IN ORDER OF INCREASING MEAN RANK OF THE COLLEGE FACULTY

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Have three or four tests evenly spaced throughout the semester	1.46	1.98	.52
Prepare students for intelligent functioning in a contemporary world.	1.50	1.94	.44
Increase the student's powers of observation in the living world.	1.58	1.73	.15
Develop scientific attitudes which logically emerge from the treatment of biology as a dynamic state.	1.72	2.23	.51
Make use of the increased effectiveness of a test as a powerful teaching tool by rapidly grading and returning to the student.	1.76	1.94	.18
Have provisions for a student study area where students can meet with other students and faculty.	1.83	1.98	.15
Be taught using a combination of lecture, inquiry and individual study.	1.95	1.85	.10

TABLE III (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Be a comprehensive course.	2.00	2.05	.05
Have well defined behavioral objectives both in the classroom and laboratory.	2.04	2.02	.02
Have a regular laboratory period which is coordinated with classroom lectures.	2.09	2.16	.07
Have available a departmental tutor to help students with individual academic problems.	2.09	2.15	.06
Place increased emphasis on the social implications of biology.	2.10	2.02	.08
Include the basic rules of scientific research which will give students some insight into the way scientists work.	2.17	2.27	.10
Adjust the method of instruction to the type students found in the classroom at any one time.	2.17	2.05	.12
Have definite provisions for individual study.	2.21	1.92	.29
Have a comprehensive examination at the end of the semester.	2.35	3.06	.71
Include some group study problems.	2.45	2.26	.19
Provide training in the basic skills of laboratory techniques.	2.45	1.97	.48

TABLE III (Continued)

Opinionnaire Statements	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Use the text chosen for the course as a guide for the development of curriculum content.	2.49	2.53	.04
Be centered around laboratory work.	2.50	2.61	.11
Have standards of achievement for the course established prior to testing.	2.53	2.32	.21
Be a one semester course.	2.63	3.26	.63
Include science majors as well as nonmajors.	2.81	2.61	.20
Be taught by the inquiry method.	2.81	2.53	.28
Have laboratory experiments so designed that each student proceeds at his own rate.	2.82	2.18	.64
Give the student a list of specific class performances required for an A, B, etc.	2.85	2.35	.50
Give the students the option of working on an individual project in lieu of other course requirements.	2.88	1.87	.01
Have a laboratory structured around key experiments in a laboratory manual.	3.04	2.58	.46

TABLE III (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Have a flexible laboratory period with various students groups working on different aspects of a common problem.	3.06	2.53	.53
Teach fewer topics and teach them in depth.	3.13	2.81	.32
Have no one text. Make library assignments or use paper back books.	3.18	3.16	.02
Have the student help in defining the behavioral objectives for the laboratory.	3.22	2.63	.59
Give the students an opportunity to analyze statistical data.	3.23	3.08	.15
Be taught by the lecture method primarily.	3.50	4.24	.74
Omit the laboratory in favor of films, slides and classroom demonstrations.	4.08	3.71	.37

Table IV compares the difference in mean rank between the two groups on the methodology and philosophy section of the opinionnaire. The statements with which both groups of respondents most closely agree are given first. The area of greatest disagreement are found at the end of the table.

TABLE IV

RESPONSES TO METHODOLOGY STATEMENTS OF THE COLLEGE BIOLOGY FACULTY AND ELEMENTARY TEACHERS IN ORDER OF DIFFERENCE IN MEAN RANK

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Have no one text. Make library assignments or use paper back books.	3.18	3.16	.02
Have well defined behavioral objectives both in the classroom and laboratory.	2.04	2.02	.02
Use the text chosen for the course as a guide for the development of curriculum content.	2.49	2.53	.04
Be a comprehensive course.	2.00	2.05	.05
Have available a departmental tutor to help students with individual academic problems.	2.09	2.15	.06
Have a regular laboratory period which is coordinated with classroom lectures.	2.09	2.16	.07
Place increased emphasis on the social implications of biology.	2.10	2.02	.08
Include the basic rules of scientific research which will give students some insight into the way scientists work	2.17	2.27	.10

TABLE IV (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Be taught using a combination of lecture, inquiry and individual study.	1.95	1.85	.10
Be centered around laboratory work.	2.50	2.61	.11
Adjust the method of instruction to the type of students found in the classroom at any one time.	2.17	2.05	.12
Give students an opportunity to analyze statistical data.	3.23	3.08	.15
Include science majors as well as nonmajors.	2.81	2.61	.15
Have provisions for a student study area where students can meet with other students and faculty.	1.83	1.98	.15
Increase the student's powers of observation in the living world.	1.58	1.73	.15
Make use of the increased effectiveness of a test as a powerful teaching tool by rapidly grading and returning to the student.	1.76	1.94	.18
Include some group study problems.	2.45	2.26	.19
Have standards of achievement for the course established prior to testing.	2.53	2.32	.21
Be taught by the inquiry method.	2.81	2.53	.28

TABLE IV (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Have definite provisions for individual study.	2.21	1.92	.29
Teach fewer topics and teach them in depth.	3.13	2.81	.32
Omit the laboratory in favor of films, slides and classroom demonstrations.	4.08	3.71	.37
Prepare students for intelligent functioning in a contemporary world.	1.50	1.94	.44
Have a laboratory structured around key experiments in a laboratory manual.	3.04	2.58	.46
Provide training in the basic skills of laboratory techniques.	2.45	1.97	.48
Give the students a list of specific class performances required for an A, B, etc.	2.85	2.35	.50
Develop scientific attitudes which logically emerge from the treatment of biology as a dynamic state.	1.72	2.23	.51
Have three or four tests evenly spaced throughout the semester.	1.46	1.98	.52
Have a flexible laboratory period with various student groups working on different aspects of a common problem.	3.06	2.53	.53

TABLE IV (Continued)

Opinionnaire Statement	CBF (mean rank)	ET (mean rank)	DIFFERENCE IN MEAN RANK
Have the students help in defining the behavioral objectives for the laboratory.	3.22	2.63	.59
Be a one semester course.	2.63	3.26	.63
Have laboratory experiments so designed that each student proceeds at his own rate.	2.82	2.18	.64
Have a comprehensive examination at the end of the semester.	2.35	3.06	.71
Be taught by the lecture method primarily.	3.50	4.24	.74
Give the students the option of working on an individual project in lieu of other course requirements.	2.88	1.87	1.01

The educators reaction to areas which definitely should receive emphasis in a general biology course are given in Table V. Opinionnaire statement 76 listed fourteen areas and the educators were asked to rank them as to the amount of emphasis they should recieve. The data found in Table V lists the areas in order of greatest emphasis as determined from college biology respondents. The response to the college biology faculty opinionnaire statement 77 is tabulated in Table VI.

TABLE V

OPINIONNAIRE RESPONSES TO AREAS WHICH SHOULD DEFINITELY BE EMPHASIZED IN ANY COLLEGE GENERAL BIOLOGY COURSE

Area	CBF (mean rank)	ET (mean rank)
Ecology (plant and animal)	1.85	1.80
Ecology (human)	1.91	1.67
Genetics	2.17	2.60
Social implications	2.18	2.64
Reproductive biology	2.21	2.55
Cell biology	2.32	2.70
Evolution	2.51	3.55
Molecular biology	2.80	3.00
Behavior and its biological basis	2.87	2.39
Human disease and health	2.89	.173
Plant and animal physiology	2.90	2.26
Kinds of organisms	2.96	2.29
Development	3.08	2.32
History of life	3.20	2.98

TABLE VI

OPINIONNAIRE RESPONSES TO A CENTRAL THEME AROUND WHICH TO DEVELOP A GENERAL EDUCATION BIOLOGY COURSE

Theme	% of Total CBF
Ecology (plant and animal)	25.64
Evolution	17.95
Cell biology	14.10
Ecology (human)	10.26
Social implications of biology	8.97
Kinds of organisms	3.85
Molecular biology	2.56
Genetics	2.56
Plant and animal physiology	1.28
Human disease and health	1.28
History of life	0.00
Reproductive biology	0.00
Development	0.00
Behavior and its biological basis	0.00

<u>Science courses taken in college provided the elementary teacher with an adequate science background</u>. Sixty five per cent of the elementary teachers responding to this statement indicated they did not have an adequate science background. Forty five per cent of the respondents who indicated the science course they took in college gave them an adequate science background received their biology training in universities; 55 per cent received their training in state colleges.

<u>The instructor of the college general biology class is primarily concerned with research</u>. Sixty three per cent of the elementary teacher participants believed the instructor to be concerned primarily with teaching. Another eight per cent felt that the instructor was concerned primarily with research with 21 per cent undecided.

<u>To be an effective teacher of college science courses the person should be involved in some scientific research.</u> Of the elementary teachers responding to this statement 56 per cent indicated that it was not necessary for the college science teacher to be engaged in scientific research to be an effective teacher of science. The response from the college biology faculty indicated that 51 per cent believed that research was necessary for effective college teaching.

<u>Persons involved in research have little time to prepare lecture material</u>. The response from the college biology faculty showed that 47 per cent agreed with this statement compared with 42 per cent of the elementary teachers. Twelve per cent of the college biology faculty returned written statements giving a qualified answer to the statement. Ninety nine per cent of the college biology faculty returning the opinionnaire responded that the primary emphasis of their job was in the area of teaching.

Sixty nine per cent of the college biology faculty respondents indicated that their institution does not have a nonmajors biology course. The college biology faculty response to the opinionnaire statement concerning the major and nonmajor showed that 48 per cent agreed that a general biology course should include both majors and nonmajors. Thirty seven per cent of the college biology faculty disagreed; indicating a separate course should exist for the science major and nonmajor.

Summary

Forty statements related to course content were rated by college biology faculty and elementary teachers as to their relative importance in a model college biology course. Forty figures and four tables were used to present the findings of this section of the opinionnaire. Forty statements related to methodology and philosophy were also rated by the same groups of college biology faculty and elementary teachers as to their relative importance in a model college biology course. Thirty five figures and two tables were used to present the results of the last section of the opinionnaire. The over-all results from the study of the areas as outlined in Chapter I are as follows:

Course content. Table I lists biology topics in order of increasing mean rank of the college biology faculty. The first seven topics on the list reveals those topics which the college faculty respondents indicated should receive the strongest emphasis in a model biology course; each receiving a rank of less than 2.00. Four of the seven topics relate to ecology. The other topics are concerned with common life processes, cellular function and homeostasis. The first seven topics also seem to be of a more general nature than other topics further down the list. Table V refers to general topics which should definitely be emphasized in a model general biology course and the two ecology areas are at the top of this list. Elementary teachers listed only one other area, health and disease, as one which should receive about as much emphasis as ecology. Table VI, which lists responses from college biology faculty only, reveals four general areas around which a biology course could be developed: ecology (plant and animal), evolution, cell biology, ecology (human).

Table II reveals the agreement between the two groups based on the difference in mean rank. Those topics which are found at the beginning of the list having the same or slightly different mean ranks indicate the two groups ranked the topics in a similar way. Those topics which are found at the end of the list reveal the greatest difference in opinions which the two groups indicated the same topics should receive. The last six topics with the widest spread in mean difference consists of topics in molecular biology, evolution, homeostasis and ecology.

Methodology and Philosophy. Table III shows the methods of instruction given the highest ranks by both groups were making provisions for student study areas and having the course presented by a combination of lecture, inquiry and individual study. In the philosophy area the two groups gave a high rank to the preparation of students for intelligent functioning in a contemporary world and to increase the student's powers of observation. Table IV reveals both groups gave a similar ranking (close to 3.17) to the opinionnaire statement concerned with having no one text as well as behavioral objectives both in the classroom and laboratory (close to 2.03). The two groups showed the widest range in mean rank concerning the use of the lecture method primarily and giving the student the option of working on an individual project in lieu of other course requirements.

Individual Study. Provisions for a student study area, a departmental tutor and adjusting the method of instruction to the individuals found in the classroom at any one time were among the first 14 statements listed under Table III. The departmental tutor elicited the greatest common response in the study.

Laboratory. A regular laboratory period which is coordinated with classroom lectures is tenth on the list under Table III. The difference in mean rank for the two groups on this statement is .07. A biology course centered around laboratory work is found to be twentieth on the list under Table III. The difference in mean rank between the two groups on this statement is .11.

Methods of Evaluation. The first item listed under Table III is the evaluation statement concerning three or four tests evenly spaced throughout the semester which is the highest mean rank given to an evaluation statement by the college biology faculty. The difference in mean rank between the two groups on this statement was .48. The fifth item on the same table which reveals another high ranking statement concern the increased effectiveness of a test by rapidly grading and returning to the student. The two groups gave a similar ranking to this statement with a mean rank difference of .18.

Behavioral Objectives. The statement concerning well defined behavioral objectives both in the classroom and laboratory appeared as number nine on Table III. The two groups ranked this statement is a similar way with a difference in mean rank of .02. The lowest ranked behavioral objective statement was: Have the student help in defining the behavioral objectives for the laboratory. This item is listed as number 32 under Table III. The difference in mean rank between the two groups on this statement is .59.

Major and Nonmajor Students. A majority of the elementary teachers responded that the model biology course should include science majors as well as nonmajors. One third of the college biology faculty agreed and one third were undecided.

Research and Teaching. It was the opinion of the majority of the elementary teachers responding that their college biology instructors had been primarily concerned with teaching; 99 per cent of the college biology faculty indicated their primary emphasis was teaching. A majority of both groups responded that research and classroom lecture preparation could be adequately accomplished.

Pearson's product moment of correlation (Pearson's r) between the two groups on the course content section of the opinionnaire was 0.24; for the methodology and philosophy portion of the opinionnaire, r was 0.76; for the course content, methodology and philosophy sections combined r was 0.49.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was made to gather opinions on the college general biology course in the State of Oklahoma and the role of this course in the training of elementary teachers. A summary of the study is followed by the conclusions. An outline of a college general biology course based on the data from this study is presented in Appendix D. Recommendations are also presented which include suggestions for further research pertinent to a biology course as an integrated part of the preservice training of elementary teachers.

Summary

This study reveals which course concepts should receive the greatest amount of emphasis in a general biology course; the methods by which the concepts should be presented and the scientific attitudes which should be developed by the students. Opinions relative to course content, methodology and philosophy gathered from the college biology faculty and elementary teachers were tabulated into tables so those items which appear first are those which the college biology faculty indicated should receive the greatest emphasis in a model college introductory biology course. A tabulation of the results revealed certain patterns. Both respondent groups indicated ecology should receive first consideration as a central theme in an ideal biology course; evolution and cell biology also received high rankings and could be considered. General unifying biologic principles were brought forth by the degree of emphasis given each topic by the Oklahoma college biology faculty.

The first eight course content topics listed are general topics and the items which follow these in the table are more specific aspects of these selected general principles. Other general principles, which the group indicated were not as important in an introductory course, occupy a lower position. A Pearson's r of 0.24 on course content show only slight agreement between the two respondent groups concerning those topics which should be emphasized in a general biology course.

The seven highest ranked items under methodology and philosophy included the students attitude toward science, the relationship of science to the student's environment, the effectiveness and number of tests given and the combination of lecture, inquiry and individual study in presentation of material. A Pearson's r of 0.76 on methodology and philosophy reveal there was good agreement between the two groups of educators concerning how the topics should be presented and attitudes which should be developed.

It was assumed in the study that opinions gathered from the college faculty would be more valuable than opinions gathered from elementary teachers in developing a list of items in order of importance. The elementary teachers responses were compared to the college biology faculty responses on each item so areas of similar and dissimilar rankings would be revealed. In the development of a college biology course with special emphasis on the training of elementary teachers, the responses should be studied and appropriate choices made.

Conclusions

A ranking of biologic principles in order of importance by Oklahoma's college biology faculty has been obtained by this study. Trends in methodology have been revealed. General and specific areas of agreement and disagreement between the two educator groups have been elucidated.

The results from this study could be used by curriculum designers as a guide in developing introductory biology courses. The ranking of content topics could be used as a source of information from which a standarization of the general biology course could be achieved. The responses from elementary teachers should be carefully considered in the development of a biology course designed to give special emphasis to the preservice training of elementary teachers. The difference in responses by the two groups used in this study may be related in part to an inadequate science background of elementary teachers and the demands new science programs place on them. The personal data revealed that only 5 per cent of the elementary teachers were actually using any of the special science curriculum programs described earlier in this study. Another 12 per cent indicated they were using other types of special science teaching materials. This may be another explanation of the disagreement between elementary teachers and college faculty on some items.

Recommendations

The following recommendations are made:

1. Standarize general biology courses in the State of Oklahoma using the results of this study as a guide.

2. Determine why Oklahoma's elementary schools are not using new science programs.

3. Determine how great the need is for in-service institutes for teachers either using or planning to use the new science curricula programs.

4. Determine if the opinions expressed by the college biology faculty are actually practiced in the college general biology classroom.

5. Determine the feasibility of a two semester general biology course.

6. Determine methods of evaluation in a general biology course which is taught using the inquiry method primarily.

7. Determine the effects of alternate methods of teaching in both large and small sections of introductory college biology courses.

8. Determine how many of Oklahoma's institutions of higher education actually make use of behavioral objectives in the course work for college general biology.

9. Determine why there is little agreement between the college biology faculty and elementary teachers on the amount of emphasis which course topics should receive.

10. Design an experimental biology course for prospective elementary teachers in a manner that the respondents to this study agree would be ideal. Test these students at the end of the semester for a change in attitude toward science, skills for problem solving and knowledge of basic scientific principles.

SELECTED BIBLIOGRAPHY

1. Abell, Dana, "On Going Underground--And Coming Back Again," CUEBS News, Volume 6, Washington, D. C., December, 1969.

2. Balzer, LeVon, "Environmental Education in the K-12 Span," The American Biology Teacher, Volume 33, (April, 1971), pp. 220-225.

3. Bell, Paul E., "An Exploration of Alternative Methods for Teaching Large Sections of General Education Biology," Journal of Research in Science Teaching, Volume 7, (1970), pp. 363-369.

4. Blazier, Richard, "Proposals for General Biology in the Community College," The American Biology Teacher, Volume 33, (April, 1971), pp. 228-231.

5. Bloom, Benjamin S. et. al., Taxonomy of Educational Objectives: Handbook I, The Cognitive Domain, New York: Longmans, Green and Co., 1956.

6. Blough, Glenn, O. et. al., "Teaching and Evaluating Science in the Elementary School," Rethinking Science Education, The Fifty-ninth Yearbook of the National Society for the Study of Education, Chicago, (1960), p. 136.

7. Borg, Walter, R., Educational Research, New York: David McKay Co., 1963.

8. Boulos, Sami I., "Proposal for an Experiment in Training Elementary Teachers," Science Education, Volume 54, (April-June), pp. 203-207.

9. Bruner, Jerome S., The Process of Education, Cambridge, Mass: Harvard University Press, 1966.

10. Burns, Richard and Barbara Ellis, "What is Discovery Learning?" Science Education, Volume 54, (April-June, 1970), pp. 105-107.

11. Butts, David P., "Relationship of Problem Solving Ability and Science Knowledge," Science Education, Volume 49, (March, 1965), pp. 138-145.

12. Carpenter, Ronald, Administrator: Teacher Education and Certification in Oklahoma, "Personal interview to obtain names of recent elementary teachers certified in science," Oklahoma City, Oklahoma, March, 1972.

13. Cleaver, Thomas J., "Inquiry Objectives in Curriculum Development," The American Biology Teacher, Volume 32, (1970), pp. 476-479.

14. Commission on Undergraduate Education in the Biological Sciences, Biology In A Liberal Education, edited by Jeffrey Baker, CUEBS publication 19, Washington, D. C., July, 1967.

15. Commission on Undergraduate Education in the Biological Sciences, Biology For The Nonmajor, edited by Jeffrey Baker, CUEBS publication 19, Washington, D. C., July, 1967.

16. Commission on Undergraduate Education in the Biological Sciences, Modules: The Use of Modules In College Biology Teaching, edited by Joan Creager and Darrel Murray, CUEBS publication 31, Washington, D. C., March, 1971.

17. Commission on Undergraduate Education in the Biological Sciences, The Laboratory: A Place To Investigate, edited by John W. Thornton, CUEBS publication 33, Washington, D. C., April, 1972.

18. Connelly, F. Michael, Enquiry Materials in Science Teaching, Ontario Institution for Studies in Education, ERIC (Ed. 040 857), November, 1969.

19. Cunningham, John, "New Developments in Elementary School Biology," The American Biology Teachers, Volume 28, (March, 1966), pp. 193-198.

20. Dean, Donald S., "The Laboratory: Learning Science by Being a Scientist," CUEBS News, Volume 6, December, 1969.

21. Dean, Donald, "Effective Science Teaching in Colleges," The American Biology Teacher, Volume 32, December, 1970, pp. 523-526.

22. Dressel, Paul L., College and University Curriculum, California: McCutchan Publishing Corporation, 1968.

23. Dunham, Alden E., Colleges of the Forgotten Americans, New York: McGraw-Hill, 1969.

24. Ericksen, Stanford C., "Earning and Learning by the Hour," Effective College Teaching, Edited by W. H. Morris, American Association for Higher Education, Washington, D. C., 1970.

25. Gagne, Robert M., "The Learning Requirements for Enquiry," Journal of Research in Science Teaching, Volume 1, (1963), pp. 144-153.

26. Gagne, Robert M., "Elementary Science: A New Scheme of Instruction," Science, Volume 151, (January, 1966), pp. 49-53.

27. Gagne, Robert M., Process in Science for the Elementary Grades, Sixteenth Annual Convention of the National Science Teachers Association, Washington, D. C., March 31, 1968.

28. Ginsburg, Benson W., Chairman, "Preparing the Modern Biology Teacher," Position Paper of the Panel on Preparation of Biology Teachers, BioScience, Volume 15 (December, 1965), pp. 769-773.

29. Good, Carter V., Essentials of Educational Research, New York: Appleton-Century-Croft, 1966.

30. Grobman, Arnold B., "School Biology of the Future: Some Considerations," The American Biology Teacher, Volume 29, (May, 1967), pp. 351-355.

31. Hall, Thomas S., "New Directions in Teaching Biology," BioScience, Volume 14, (April, 1964), pp. 31-33.

32. Hankins, Lela R., "A Problem Solving Approach to the Teaching of Biology at the College Freshman Level for the Purpose of General Education," The Biologist, Volume 52, (February, 1970), pp. 16-35.

33. Hardin, Garrett, "A Path to Relevant Teaching," Effective College Teaching, edited by W. H. Morris, American Association for Higher Education, Washington, D. C., (1970), pp. 87-93.

34. Hernandez, Dolores and Benito S. Vergara, "Introducing Biology Curriculum Innovations in Philippine Schools," The American Biology Teacher, Volume 30, (January, 1968), pp. 26-30.

35. Hines, Sallylee, "A Study of Certain Factors Which Affect the Opinions of Elementary School Teachers in the Training of Science," unpublished doctoral dissertation, Oklahoma State University, 1966.

36. Holt, C. E. et. al., "Investigative Laboratory Programs in Biology," BioScience, Volume 19, (December, 1969), pp. 1104-1107.

37. Hopman, Ann B., "Effecting Changes in the Elementary Science Curriculum of a School System," Science Education, Volume 48, (March, 1964), pp. 101-109.

38. Hurd, Paul DeHart et. al., "Science Education for Changing Times," Rethinking Science Education, The Fifty-ninth Yearbook of the National Society for the Study of Education, Chicago, Illinois: The University of Chicago Press, 1960, pp. 18-38.

39. Hurd, Paul DeHart, Biological Education in American Secondary Schools, 1890-1960, Biological Sciences Curriculum Study, Bulletin No. 1, American Institutie of Biological Sciences, 1961.

40. Hurd, Paul DeHart, "The New Curriculum Movement in Science," The Science Teacher, Volume 29, (February, 1962), pp. 6-9.

41. Hurd, Paul D., and James J. Gallagher, New Directions in Elementary Science Teaching, California: Wadsworth Publishing Company, 1968.

42. Hutto, Thomas A., "A Need for Direction in the College Biology Curriculum," The American Biology Teacher, Volume 27, (1965), pp. 24-25.

43. Kessen, William, "Statement of Purposes and Objectives of Science Education in School," Journal of Research in Science Teaching, Volume 2, (1964), pp. 3-6.

44. Koran, John J. Jr., "Concepts and Concept-Formation in the Teaching of Biology," The American Biology Teachers, Volume 33, (October, 1971), pp. 405-408.

45. Kuhn, David, "Laboratory Experiences in Biology for the Elementary Teacher," CUEBS News, Volume 6, August, 1970, p. 7.

46. Kurtz, E. B. Jr., "Help Stamp Out Nonbehavioral Objectives," Science Teacher, Volume 32, (1965), pp. 31-32.

47. Kurtz, E. B. Jr., "Biology in Science--A Process Approach," The American Biology Teachers, Volume 29, (March, 1967), pp. 192-196.

48. Laetsch, Watson M., "College Biology and the Captive Nonmajor," The American Biology Teacher, Volume 29, (April, 1967), pp. 297-299.

49. Lawson, Chester, A., "The Life Science Program of the Science Curriculum Improvement Study," The American Biology Teacher, Volume 29, (March, 1967), pp. 185-190.

50. Lee, Addison E., "Main Points of the McREL-BSCS Document," The American Biology Teacher, Volume 32, (November, 1970), pp. 474-475.

51. Lippincott, W. T., "The Major Critical Problems in the American University: Quality Teaching in the Freshman and Sophomore Years," BioScience, Volume 16, (February, 1966), pp. 98-101.

52. Mayer, William V., "Biology--Synthesizer of Science or Disintegrating Discipline?" The American Biology Teacher, Volume 30, (December, 1968), pp. 799-805.

53. McKinney, Larry, Administrator: Instructional Division, Science Specialist, Oklahoma State Department of Oklahoma, "Personal interview to obtain IBM listing of elementary teachers who graduated from Oklahoma's institutions of higher education," Oklahoma City, Oklahoma, February, 1972.

54. Murray, Darrel L., "The Laboratory: A Place for Investigation," CUEBS News, Volume 6, December, 1969, p. 4.

55. National Science Teachers Association, Science Education for Elementary Teachers, Final Report, ERIC (ED 039 132) Washington, D. C., October, 1968.

56. Nisbet, Jerry J. and Thomas R. Mertens, "Curriculum Reform at Ball State University," The American Biology Teacher, Volume 33, (January, 1971), pp. 33-37.

57. Novak, Alfred, "Scientific Inquiry in the Laboratory," The American Biology Teacher, Volume 25, (May, 1963), pp. 342-346.

58. Novak, Alfred, "The Model Biology Curriculum," BioScience, Volume 16, (August, 1966), pp. 519-523.

59. Oklahoma Association for Undergraduate Education in Biology, Faculty Directory, Oklahoma State University, Stillwater, Oklahoma, 1971-72.

60. Olson, J. Bennet, "General Biology and the Future Elementary School Teacher," CUEBS News, Volume 5, April, 1969, p. 4.

61. Popham, James, Educational Statistics, New York: Harper and Row, 1967.

62. Postlethwait, S. N., J. Novak and H. T. Murray, The Audio-Tutorial Approach to Learning, Minneapolis, Minn.: Burgess Publishing Company, 1969.

63. Postman, N., and C. Weingartner, Teaching as a Subversive Activity, New York: Delacorte Press, 1969.

64. Preservice Science Education of Elementary Teachers, AAAS Commission on Science Education, Miscellaneous Publication 70-5, Washington, D. C., April, 1970.

65. Raven, Ronald J. "Toward a Philosophical Basis for Selecting Science Curriculum Content," Science Education, Volume 54, (April-June, 1970), pp. 97-103.

66. Redfield, David D., and R. K. Atwood, "An Investigation of an Experiment Model in the Physical Sciences for the Junior High Student," Journal of Research in Science Teaching, Volume 4 (1966), pp. 217-226.

67. Renner, John W. and William B. Ragan, Teaching Science in the Elementary School, New York: Harper and Row, 1968.

68. Roos, Thomas B., "An Introduction to the Biological Sciences," BioScience, Volume 15, (October, 1965), pp. 660-664.

69. Runyon, Richard P. and Audrey Haber, Fundamentals of Behavioral Statistics, Mass.: Addison-Wesley, 1967.

70. Scherba, Gerald, "Animal Behavior in the Introductory Biology Course," The American Biology Teacher, (October, 1967), pp. 523-527.

71. SCIS Newsletter, Robert Karplus editor, Number 15, Summer, 1969.

72. SCIS Newsletter, Robert Karplus, editor, Number 16, Fall, 1969.

73. Shamos, Morris H., "The Art of Teaching Science," Effective College Teaching, Edited by W. H. Morris, American Association for Higher Education, Washington, D. C., 1970, pp. 66-86.

74. Shulman, Lee S., "Psychological Controversies in the Teaching of Science and Mathematics," The Science Teacher, Volume 35, (September, 1968), pp. 34-38, 89-90.

75. Siegel, Sidney, Nonparametric Statistics for the Behavioral Sciences, New York: McGraw-Hill, 1956.

76. Simmons, R. H., "Elementary Science a New Discipline and Growing Responsibility for the Teacher Training College," Science Education, Volume 43, (October, 1959), pp. 336-341.

77. Suchman, Richard J., "Inquiry in the Curriculum," Instructor, Volume 75, (January, 1966), p. 24.

78. The Improvement of Science Instruction in Oklahoma, Grades K-6, The State Science Committee of the Oklahoma Curriculum Improvement Commission, The Oklahoma State Department of Education, 1971.

79. Thomson, Barbara S. and Alan M. Voelker, "Programs for Improving Science Instruction in the Elementary School," Science and Children, Volume 7, (May, 1970), pp. 29-36.

80. Victor, Edward, "Why are our Elementary Teachers Reluctant to Teach Science?" Science Education, Volume 46, (March, 1962), pp. 185-192.

81. Victor, Edward, Present Programs and Major Curriculum Developments in Elementary School Science--A Critique, The Sixteenth Annual Convention, National Science Teachers Association, Washington, D. C., March 30, 1968.

82. Walbesser, Henry H., "Science Curriculum Evaluation: Observations on a Position," Science Teacher, Volume 33, (1966), pp. 34-39.

83. Walcott, Charles, "Elementary School Biology," The American Biology Teacher, Volume 29, (March, 1967), pp. 180-184.

84. Wyatt, Stanley P. and J. Myron Atkin, "Elementary Science," Science Education News, Washington, D. C., December, 1961.

APPENDIX A

LETTERS SENT TO EDUCATORS

OKLAHOMA STATE UNIVERSITY • STILLWATER

Research Foundation
(405) 372-6211, Ext. 271

74074

Dear Colleague:

There has been no period in the history of American higher education that is more important than the present for beginning a restructuring of college courses and programs in all areas of liberal arts education. This is particularly true of undergraduate biology courses.

There has been such proliferation of biological knowledge that it is becoming increasingly harder to select the more important biological concepts to be included in the introductory courses. New types of teaching aids and advances in learning theories require much planning to organize available material and information into a meaningful, productive curriculum which will meet the needs of all students.

The most important student in any general biology course could well be the future elementary teacher. An important question which needs to be answered is what kind of general biology course will give them the desire and confidence to bring science into the proper perspective in their future classroom teaching? The new methods of teaching elementary science place a greater demand on the future elementary teacher to have earlier and more meaningful experiences in science. There may be some justification for a special course in general biology for future elementary teachers that would differ more in attitude than content.

To determine the present status of thinking on biology curriculum reform, opinionnaires are being sent to elementary teachers in the state of Oklahoma. If you fill out, staple and return the self-addressed opinionnaire you will have a positive effect on strengthening the pre-service training program of elementary teachers. Individual schools or teachers will not be identified in any way.

Sincerely,

Dorothy Frosch
Doctoral Candidate
Oklahoma State University

Kenneth Wiggins
Assistant Director
Research Foundation
Oklahoma State University

OKLAHOMA STATE UNIVERSITY • STILLWATER

Research Foundation
(405) 372-6211, Ext. 271

74074

Dear____________________:

About April 10, 1972, I sent a letter and an opinionnaire form asking for your help in An Investigation of the College General Biology Curriculum as an Integrated Part of the Pre-Service Training of Elementary Teachers.

To make this a valid and worthwhile study I especially need your help in completing this part of my research. A self-addressed stamped opinionnaire is enclosed for your convenience. Would you please take some time now to complete the opinionnaire and return it to me as soon as possible? Much has been written about the lack of concern of college instructors in the academic fields regarding programs at the elementary school level. This study is an effort to open channels of communication between these two levels and restructure existing college curricula if the results from the opinionnaires show a need to do so. I feel certain you wish to participate in this survey and by completing the enclosed opinionnaire you will be contributing to my study important information that comes from successful teaching experiences. Your response would be deeply appreciated and I would be sincerely grateful.

Your information will be kept confidential. Coding, by number, has been a necessity in order to follow up on those not responding.

Sincerely,

Dorothy Frosch
Doctoral Candidate
Oklahoma State University
Stillwater, Oklahoma 74074

OKLAHOMA STATE UNIVERSITY • STILLWATER
Research Foundation 74074
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There has been such proliferation of biological knowledge that it is becoming increasingly harder to select a core of the more important biological concepts to be included in the introductory courses. Technological advances have established new types of teaching aids and psychology has produced new learning theories. It will take much insight and planning to organize available material and information into a meaningful, productive curriculum that will meet not only the education objectives of today but for the remaining critical years of this century as well.

It is for these reasons that we are contacting instructors, like yourself, who have had responsibility for planning, organizing, instructing and evaluating the general biology course. You are the only ones who can and should help identify the most important concepts to be included in the general course; the only ones who can make constructive suggestions concerning methodology and course objectives. Because of your experience in these areas we need your help in assessing the current thinking and future trends relative to the general biology curriculum.

To determine the present status of thinking on curriculum reform, opinionnaires are being sent to biology instructors in the state of Oklahoma who have responsibility for planning, organizing, instructing and evaluating the general biology course. You will be making a positive contribution to the teaching profession by filling out, stapling and returning the self-addressed opinionnaire. Individual institutions or instructors will not be identified in any way.

Sincerely,

Dorothy Frosch
Doctoral Candidate
Oklahoma State University

Kenneth Wiggins
Assistant Director
Research Foundation
Oklahoma State University

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(405) 372-6211, Ext. 271

74074

Dear____________________:

About March 30, 1972, I sent a letter and an opinionnaire form asking for your help in an investigation of the College General Biology Curriculum in Oklahoma's Institutions of Higher Education.

To make this a valid and worthwhile study I especially need your help in completing this part of my research. A self-addressed, stamped opinionnaire is enclosed for your convenience. Would you please take some time now to complete the opinionnaire and return it to me as soon as possible? I feel certain you wish to participate in this survey and by conveying your opinions concerning the general biology curriculum you will be contributing to my study important information that comes from successful teaching experiences. Your response would be deeply appreciated and I would be sincerely grateful.

Your information <u>will be kept confidential</u>. Coding, by number, has been a necessity in order to follow up on those not responding.

Sincerely,

Dorothy Frosch
Doctoral Candidate
Oklahoma State University
Stillwater, Oklahoma 74074

APPENDIX B

OPINIONNAIRES SENT TO EDUCATORS

AN INVESTIGATION OF THE COLLEGE GENERAL
BIOLOGY CURRICULUM IN OKLAHOMA'S
INSTITUTIONS OF HIGHER EDUCATION

Opinionnaire

Personal Data Sheet

In the following statements, please check the appropriate blanks or fill in the general information as it applies to you.

1. Teaching experience (including this year).

Elementary		Secondary		College	
0- 5	____	0- 5	____	0- 5	____
6-10	____	6-10	____	6-10	____
11-15	____	11-15	____	11-15	____
16 or more	____	16 or more	____	16 or more	____

2. Age: 60 or above_____
   50 to 59_____
   40 to 49_____
   30 to 39_____
   20 to 29_____

3. Sex: Male________; Female________

4. Institution where you teach: University____, State College____, Liberal Arts College_____, Junior College_____.

5. Level of academic training:

type		institution granting degree
Bachelor's Degree	____	________________
Associate Degree	____	________________
Master's Degree	______	________________
Ed.D.	______	________________
Ph.D.	______	________________

6. The primary emphasis of your job is in: research___, teaching___.

7. Years you have taught the general biology course: 1-3____, 4-6____, 7-10____, 11-14____, 15-17____, 18-20____, 20+____.

8. Type of school where you took your general biology course: University____, State College____, Liberal Arts College____, Junior College____.

9. By use of a check mark (✓) indicate the number of general biology classes you are currently teaching: (explanation: if you are teaching two classes of less than 50 students enter two on the line indicating that category, etc.)

   class size

1-49__________	150-199________	more than 300________
50-99__________	200-249________	
100-149________	250-300________	

10. Our institution (does, does not) have two different types of general biology programs and/or laboratories, one of which is for the non-science major.

11. Textbook currently used in our general biology course:
Title__________________________, Author___________________________

12. To receive the results of this opinionnaire check the following space______.

AN INVESTIGATION OF THE COLLEGE GENERAL
BIOLOGY CURRICULUM IN OKLAHOMA'S
INSTITUTIONS OF HIGHER EDUCATION

This opinionnaire has been constructed so as to take a minimum amount of your time. You are asked to indicate on the five-point scale found at the end of each statement the degree to which you feel the statement is an important learning outcome for a college level course in general biology as a part of liberal education. To register a very strong opinion you should circle the number one (1) on the scale. To register a very weak opinion you should circle the number five (5) on the scale.

1	2	3	4	5
very strong emphasis	strong emphasis	medium emphasis	weak emphasis	very weak emphasis

In selecting the content for the ideal one semester biology course as part of liberal education certain key concepts should be stressed. Which of the following concepts, in your opinion, should receive the strongest emphasis?

1. Biologist use the species as the basic classificatory unit. The basis for classification is formed by hereditary differences 1 2 3 4 5

2. The functions of the cell provide basic information about life functions at all biological levels 1 2 3 4 5

3. Some life processes are common to all living organisms. The differences provide the basis for the diversity of life 1 2 3 4 5

4. Four basic attributes of a living system are: (a) the capacity for change (b) the capacity to store information (c) the ability to translate information for use in complex activities (d) the capacity to make copies of themselves 1 2 3 4 5

5. Photosynthetic light and dark reactions are metabolic pathways which result in the storage of energy in chemical bonds 1 2 3 4 5

6. Cellular respiration, including glycolysis, the Kreb cycle and the electron transport system involve metabolic pathways which provide energy in a form usable by all cells 1 2 3 4 5

7. The activities of living organisms result from chemical and physical processes. The chemical reactants are supplied by nutrients that must be recycled 1 2 3 4 5

8. Complex living systems are controlled in part by enzymes. Most chemical reactions occurring within a cell are controlled by regulating the amount, type and specificity of the enzyme present 1 2 3 4 5

9. The universal genetic code is based on various combinations of four different nucleotides. A single coding unit consisting of three such nucleotides usually specifies a particular amino acid 1 2 3 4 5

10. There are four basic groups of organic compounds that form the basis of the structure and function of all living components. These four groups are: carbohydrates, lipids, proteins and nucleic acids 1 2 3 4 5

11. The fundamental unit of heredity is the gene. Genes consist of DNA components arranged in a double helix on chromosomes 1 2 3 4 5

12. The phenomenon of heredity in all living things thus far investigated is attributable to the replication and transmission of the genetic materials DNA or RNA . . . 1 2 3 4 5

13. Mutation in a population is essentially random; selection converts this randomness into a pattern. Gene mutations occur at the molecular level and are the result of deleting, adding or rearranging the nucleotide components of DNA 1 2 3 4 5

14. DNA is decoded by RNA. RNA in turn determines protein specificity. The phenotype is the ultimate expression of the genotype. In this way genetic material determines characteristics of living organisms 1 2 3 4 5

15. Organisms reproduce themselves by two different methods: sexual and asexual 1 2 3 4 5

16. Adaptation has resulted in morphological and functional differences among the cells comprising an organism. This difference (specialization) resulted in the formation of tissues, organs and eventually systems 1 2 3 4 5

17. The Animal Kingdom, which can roughly be sub-divided into vertebrates and invertebrates, contains a great diversity of organisms. This diversity may be the result of evolution producing specialization. The more similar the physiological function of two different organisms the more recent their common ancestory . . . 1 2 3 4 5

18. The Plant Kingdom includes two groups of plants which are important to man: Gymnosperms and Angiosperms. Of these two groups the Angiosperm is the more advanced . 1 2 3 4 5

19. Unicellular organisms (paramecia, amoeba) perform the major functions of multicellular organisms such as ingestion, respiration, excretion, locomotion and reproduction. Such organisms have cellular organization 1 2 3 4 5

20. Osmoregulation, feeding and digestion, nitrogen excretion, circulation of body fluids and the transmission of nerve impulses are physiological processes shared by all higher animals and many of the lower animals 1 2 3 4 5

21. Absorption of water and minerals by roots, transpiration, translocation, hormonal coordination and the transformation of light energy into chemical energy are basic physiological processes which all higher plants have in common 1 2 3 4 5

22. All living systems--from cells to biomes--are in a dynamic steady-state which may be altered when a component in the system is changed 1 2 3 4 5

23. Feedback systems is one method which regulates the activities and development of living systems. A malfunction of this system may result in physiological as well as ecological disorders 1 2 3 4 5

24. The development of an organism results from the interaction of the organism's genetic endowment with its environment. Some birth defects are caused when the embryo is subjected to an unfavorable environment . . . 1 2 3 4 5

25. As a zygote divides and develops into an embryo and eventually into an adult, different groups of cells lose some of the potential toward differentiation. The early embroyonic stages of different animals may show gross morphological similarities. These similarities become less evident with further development 1 2 3 4 5

26. Animal behavior has evolved just as structure and biochemical processes have. The development of behavior is the product of both genetic and environmental interactions 1 2 3 4 5

27. Most species of microorganisms in their natural habitat are not dangerous to man; they are essential components of the ecosystem. In higher animals resistance to some disease producing microorganisms can be induced by stimulating the host's immune response to a modified specific pathogen 1 2 3 4 5

28. Plant and animal pests can best be controlled by using natural limiting factors such as disease, natural enemies and competitors 1 2 3 4 5

29. Diseases are ideally controlled by prevention rather than cure; diseases are due to natural causes. Diseases in plants and animals result from many factors such as genetic constitution, dietary deficiency, physiological dysfunction and/or may be caused by a number of parasitic organisms 1 2 3 4 5

30. The biological patterns of diversity are the result of evolution 1 2 3 4 5

31. Change is a natural phenomenon. All things--physical as well as biological--change through time. These changes may occur slowly in the amazingly stable genetic systems or rapidly as a result of drastic physical changes 1 2 3 4 5

32. No single characteristic separates plants from animals. However, there are differences which do exist between them. The first land plants and animals may have evolved from aquatic forms that succeeded in moving to a terrestrial environment through a gradual development of specialized structures and functions 1 2 3 4 5

33. One theory concerning the origin of life on earth proposes that life arose spontaneously in an aquatic environment through the interaction of energy with nonliving matter that became self-reproducing. Alga-like organisms and bacteria provide evidence of the earliest forms of life as revealed by fossils believed to be more than three billion years old 1 2 3 4 5

34. The living world is made of ecosystems. Each ecosystem consists of similar components; abiotic, producers, consumers and decomposers. It is essential that these components are present and functioning in a balanced way if ecosystems are to survive 1 2 3 4 5

35. Energy has a unidirectional flow through ecosystems. Solar energy is transformed by green plants into chemical bond energy. This stored energy is passed from the producers to animals which eat plants--then to animals which eat those animals and so on. Each time energy is transferred from one organism to another energy is dissipated resulting in a decreasing amount of energy available to sustain life 1 2 3 4 5

36. The earth has finite space, material and available energy. Its carrying capacity for living organisms is limited by surface area, the rate of cycling of water, gases and minerals and the efficiency of photosynthesis 1 2 3 4 5

37. Order is a constant theme in biology. Life is organized from the molecular and intracellular to the community and biosphere 1 2 3 4 5

38. Man is a powerful ecological force. He has modified the environment through agriculture, selective breeding, control of pests by use of chemicals, strip mining and deforestation. As a result of these activities some organisms have been controlled, some have become more troublesome while others have become extinct 1 2 3 4 5

39. Population growth in organisms is a function of the reproduction of new individuals and migration. After a slow phase, population growth from relatively low to relatively high levels usually occurs exponentially, then declines as numbers approach environmental capacity 1 2 3 4 5

40. Man's social interactions in part can be traced to basic biological behavioral patterns 1 2 3 4 5

For questions 41-75 rate each statement in the following way:

1	2	3	4	5
Strongly agree	agree	undecided	disagree	strongly disagree

A biology course with ideal objectives as a part of liberal education should:

41. Teach fewer topics and teach them in depth 1 2 3 4 5

42. Place increased emphasis on the social implications of biology (i.e. human population explosion, pollution, biological basis of human social behavior, etc.) . . . 1 2 3 4 5

43. Give students an opportunity to analyze statistical data 1 2 3 4 5

44. Include science majors as well as non-majors 1 2 3 4 5

45. Be centered around laboratory work 1 2 3 4 5

46. Include the basic rules of scientific research which will enable students to gain some appreciation of how scientists work 1 2 3 4 5

47. Be comprehensive (i.e. include ecology, behavior, physiology, genetics, development, etc.) 1 2 3 4 5

48. Be taught by the inquiry method 1 2 3 4 5

49. Have well defined behavioral objectives both in the classroom and laboratory 1 2 3 4 5

50. Have definite provisions for individual study (i.e. programed texts, audio-tutorials, assigned library research, etc.) 1 2 3 4 5

51. Have a regular laboratory period which is coordinated with classroom lectures 1 2 3 4 5

52. Have a comprehensive examination at the end of the semester to provide a reasonable means of measuring the student's academic progress 1 2 3 4 5

53. Include some group study problems 1 2 3 4 5

54. Be a one semester course 1 2 3 4 5

55. Have provisions for a student study area where students can meet with other students and faculty and have access to science study materials 1 2 3 4 5

56. Give the student a list of specific class performances required for an A, B, etc. The student then chooses the grade he desires and works toward it 1 2 3 4 5

57. Omit the laboratory in favor of films, slides and classroom demonstrations 1 2 3 4 5

58. Have no one text. Reading assignments should be made from library lists--or perhaps a series of current "paper back" books. 1 2 3 4 5

59. Have the student help in defining the behavioral objectives for the laboratory 1 2 3 4 5

60. Have a flexible laboratory period with various student groups working on different aspects of a common problem determined by the group 1 2 3 4 5

61. Have available a departmental tutor to help students with individual academic problems 1 2 3 4 5

62. Increase the student's powers of observation in the living world 1 2 3 4 5

63. Have three or four tests evenly spaced throughout the semester in preference to one test at mid-term and another at the end of the semester 1 2 3 4 5

64. Have a laboratory structured around key experiments in a laboratory manual so students will know exactly what steps to take in satisfactorily completing highly desirable experiments 1 2 3 4 5

65. Have certain standards of achievement established for the course prior to testing, rather than testing and fitting the results to the normal curve of distribution 1 2 3 4 5

66. Give students the option of working on an individual project in lieu of other course requirements such as term papers 1 2 3 4 5

67. Make use of the increased effectiveness of a test as a powerful teaching tool by rapidly grading and informing the students of their progress soon after the test is given 1 2 3 4 5

68. Develop scientific attitudes which logically emerge from the treatment of biology as a dynamic rather than a static state 1 2 3 4 5

69. Have laboratory experiments so designed that each student proceeds at his own rate with a minimum number of performances required for completion of the biology course 1 2 3 4 5

70. Use the text chosen for the course as a guide for the development of curricular content 1 2 3 4 5

71. Provide training in the basic skills of laboratory techniques 1 2 3 4 5

72. Prepare students for intelligent functioning in a contemporary world. (i.e. enable the student to more accurately interpret the many messages flowing to him from the news media, make wiser decisions as a citizen concerning environmental and/or social problems, etc.). 1 2 3 4 5

73. Be taught by the lecture method primarily 1 2 3 4 5

74. Be taught using a comgination of lecture, inquiry and individual study 1 2 3 4 5

75. Adjust the method of instruction to the type of students found in the classroom at any one time 1 2 3 4 5

Please rate the following areas which you feel should definitely be emphasized in any college general biology course. Please use the following rating scale:

1	2	3	4	5
very strong emphasis	strong emphasis	average emphasis	weak emphasis	very weak emphasis

---

76. ( ) evolution
( ) molecular biology
( ) cell biology
( ) kinds of organisms
( ) ecology (plant & animal)
( ) ecology (human)
( ) plant and animal physiology
( ) human disease and health
( ) genetics
( ) history of life
( ) reproductive biology
( ) behavior and its biological basis
( ) development
( ) social implications of biology

77. If you had to decide on only <u>one</u> of the above themes around which to develop a general education biology course which one would you choose?

    ____

    None of the above is my choice. I would use the following theme______________________________________

78. To be an effective teacher of science the person should be involved in some scientific research. Yes_______ No_______.

79. Persons involved in research usually do not have enough time to adequately prepare lecture material. Yes_______ No_______.

AN INVESTIGATION OF THE COLLEGE GENERAL BIOLOGY CURRICULUM AS AN INTEGRATED PART OF THE PRESERVICE TRAINING OF ELEMENTARY TEACHERS

Opinionnaire

Personal Data Sheet

In the following statements, please check the appropriate blanks or fill in the general information as it applies to you.

1. Teaching experience (including this year).

Elementary:	K-3	4-6
0 -5	_____	_____
6-10	_____	_____
11-15	_____	_____
16 or more	_____	_____

Secondary: 0- 5____
6-10____
11-15____
16 or more____

College: 0- 5____
6-10____
11-15____
16 or more____

2. Age: 60 or above_____
50 to 59_____
40 to 49_____
30 to 39_____
20 to 29_____

3. Sex: Male________; Female________

4. Grade you are presently teaching: K___, 1___, 2___, 3___, 4___, 5___, 6___.

5. Years you have taught the present grade level. 1-2____, 4-6____, 7-10____, 11-14____, 15-17____, 18-20____, 20+____.

6. By use of a check mark(✓)indicate the size of the class you are currently teaching: (explanation: if you are teaching two classes of less than 19 students enter two on the line indicating that category, etc.)

class size 1-19_____, 20-29_____, 30 or more_____.

7. Hours of science taught each week: 0-5____, 5-10____, 10 or more____.

8. Our school is currently using material from: AAAS____, COPES____, ESS____, ISCS____, SCIS____, Special material from programs not listed____, none of the above listed areas____.

9. Main textbook or textbook series used as a part of our elementary science program:

Title______________________________Author_________________________

Publisher__________________________

10. Level of academic training:

type	institution granting degree
Bachelor's Degree_____	________________
Associate Degree_____	________________
Master's Degree_____	________________
Ed.D._____	________________
Ph.D._____	________________

11. Type of school where you took your general biology course:
University_____, State College_____, Liberal Arts College_____,
Junior College_____.

AN INVESTIGATION OF THE COLLEGE GENERAL BIOLOGY CURRICULUM AS AN INTEGRATED PART OF THE PRESERVICE TRAINING OF ELEMENTARY TEACHERS

This opinionnaire has been constructed so as to take a minimum amount of your time. You are asked to indicate on the five-point scale found at the end of each statement the degree to which you feel the statement is an important learning outcome for a college level course in general biology as a part of the preservice training of elementary teachers. To register a very strong opinion you should circle the number one (1) on the scale. To register a very weak opinion you should circle the number five (5) on the scale.

1	2	3	4	5
very strong emphasis	strong emphasis	medium emphasis	weak emphasis	very weak emphasis

In selecting the content for the <u>ideal one semester biology course</u> as part of the preservice training of elementary teachers certain key concepts should be stressed. Which of the following concepts, in your opinion, should receive the strongest emphasis?

1. Biologist classify living organisms by ways in which they resemble one another and ways in which they differ. The species is the fundamental unit of classification . 1 2 3 4 5

2. A basic understanding of the way a cell functions provides insight into how tissues, organs, systems, populations and communities function. 1 2 3 4 5

3. All living organisms have some "life properties" in common. The differences in "life properties" result in many varying forms of life. 1 2 3 4 5

4. Living systems can be thought of as being capable of (a) changing (b) storing information (c) translating information into activities (d) making copies of themselves. 1 2 3 4 5

5. Photosynthesis consists of complex chemical reactions which result in the formation of foods. 1 2 3 4 5

6. Cells use food by means of molecular changes which result in the release of energy in a form usable by all cells 1 2 3 4 5

7. The activities of living organisms result from chemical and physical processes. Nonliving matter may become an integral part of living matter but it is returned to the nonliving state in time 1 2 3 4 5

8. Complex living systems are regulated in part by enzymes. The type as well as the amount of enzyme present in a cell determines which molecules will react and how fast they will combine 1 2 3 4 5

9. The "code of life" is based on four different molecular groups. Three such molecular groups make up <u>one</u> code unit which is a determiner for <u>one</u> amino acid 1 2 3 4 5

10. There are four basic groups of organic compounds that make up the structure and determine the function of living organisms. These four groups are: carbohydrates (sugar and starches), lipids (fats), protein and nucleic acid. 1 2 3 4 5

11. The gene is the basic unit of heredity. Genes are located on chromosomes and are composed of DNA. 1 2 3 4 5

12. The explanation of hereditary in all living things thus far studied lies in the reproduction and transmission of the molecules DNA or RNA 1 2 3 4 5

13. The change in the genetic material of a population is a random process; selection changes this randomness into a pattern. Gene changes occur at the molecular level and are the result of removing, adding or re-arranging the sub units of DNA. 1 2 3 4 5

14. The genetic code is lifted from DNA by RNA. A different type of RNA in turn uses this code to determine a specific type of protein. The physical characteristics of an organism is determined by the formation of these specific proteins. In this way an organisms' genes determine the physical characteristics of that organism. 1 2 3 4 5

15. Organisms reproduce themselves by two different methods: sexual and nonsexual. 1 2 3 4 5

16. Adaptation has resulted in structural and functional differences in cells which make up organisms. This difference resulted in the organization of cells into tissues, organs and organ systems 1 2 3 4 5

17. The Animal Kingdom, which can be roughly sub-divided into animals with backbone and animals without backbone, contain a great diversity of organisms. This diversity is the result of gradual changes occurring over a long period of time producing specialization. The greater the structural and functional similarities between organisms the more recent the common ancestry 1 2 3 4 5

18. The Plant Kingdom includes two groups of plants which are important to man: the "naked" seed plants and the flowering plants. Of these two groups the flowering plants is the more advanced 1 2 3 4 5

19. One-cell organisms perform all the basic functions of the many-celled organisms such as feeding, respiration, excretion, locomotion and reproduction. Such organisms have cellular organization. 1 2 3 4 5

20. Feeding, digestion, nitrogen excretion, circulation of body fluids, the transmission of nerve impulses and regulation through osmosis are basic life processes shared by all higher animals and many of the lower animals 1 2 3 4 5

21. Absorption of water and minerals by roots, the evaporation of water from plant cells, the transport of nutrients and the changing of light energy into food are basic life processes shared by all higher plants. . 1 2 3 4 5

22. All living systems--from cells to biomes--are actively engaged in maintaining a steady-state which may be altered when a part of the system is changed. 1 2 3 4 5

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40. Man's social interactions in part can be traced to basic biological behavioral patterns. 1 2 3 4 5

For questions 41-75 rate each statement in the following way:

1	2	3	4	5
strongly agree	agree	undecided	disagree	strongly disagree

A biology course with ideal objectives as a part of liberal education which could be an integrated part of the preservice training of elementary teachers should:

41. Teach fewer topics and teach them in depth. 1 2 3 4 5

42. Place increased emphasis on the social implications of biology (i.e. human population explosion, pollution, biological basis of human social behavior, etc.). 1 2 3 4 5

43. Give students an opportunity to analyze statistical data. 1 2 3 4 5

44. Include science majors as well as non-majors. 1 2 3 4 5

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74. Be taught using a combination of lecture, inquiry and individual study. 1 2 3 4 5

75. Adjust the method of instruction to the type of students found in his classroom at any one time. 1 2 3 4 5

76. Please rate the following areas which you feel should definitely be emphasized in any college general biology course. Please use the following rating scale:

1	2	3	4	5
very strong emphasis	strong emphasis	average emphasis	weak emphasis	very weak emphasis

---

( ) evolution ( ) molecular biology ( ) cell biology

( ) plant and animal physiology ( ) ecology (plant & animal)

( ) ecology (human) ( ) plant and animal physiology

( ) human disease and health ( ) genetics

( ) history of life ( ) reproductive biology

( ) development ( ) behavior and its biological basis

( ) social implications of biology

In the following statements, please check your agreement or disagreement by placing a in the appropriate blank.

77. The science courses taken in college provided me with an adequate background for teaching science. Yes____, No____.

78. The instructor of my college general biology class was primarily concerned with research_____, teaching_____, undecided_____.

79. To be an effective teacher of college science courses the person should be involved in some scientific research. Yes____, No____.

80. Persons involved in scientific research usually do not have enough time to adequately prepare lecture material. Yes____, No____.

1. Was the opinionnaire too long?

2. Is the purpose of the opinionnaire clear?

3. Were there any questions too personal? If yes circle the question please.

4. Is it a strongly biased opinionnaire?

5. Was the wording in a form which could be understood by most elementary teachers?

6. Was there any science area not covered that you feel should have been?

   Would you list those areas please?

7. Would you object to filling out such an opinionnaire had you received it in the mail?

APPENDIX C

GRAPHS OF RESPONSES TO OPINIONNAIRE STATEMENTS MADE BY COLLEGE BIOLOGY FACULTY AND ELEMENTARY TEACHERS

GRAPHICAL DATA

The results from the first 75 opinionnaire statements are presented here in the form of graphs. The number of the figure corresponds to the number of the opinionnaire statement. A bar graph is used and has five general divisions, each division representing one of the five possible responses. Each division is subdivided into two percentage response categories: one for the college biology faculty (CBF); the other for elementary teachers (ET). The first 40 graphs relate to the course content portion of the opinionnaire and are labeled to correspond with the rank order scale of the opinionnaire statements as follows: very strong emphasis (VSE); strong emphasis (SE); medium emphasis (ME); weak emphasis (WE); very weak emphasis (VWE).

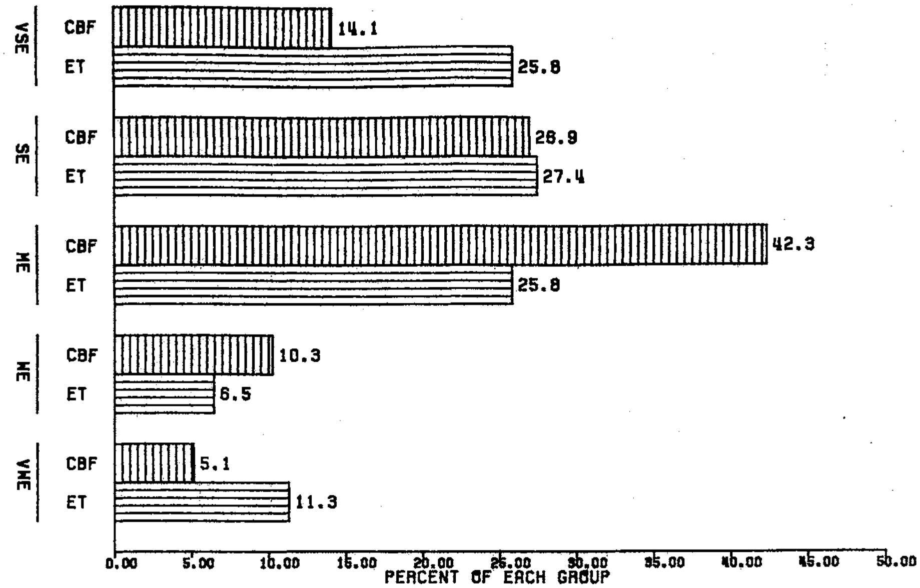

Figure 1. Responses to the Concept That the Basis of Classification is Formed by Hereditary Differences

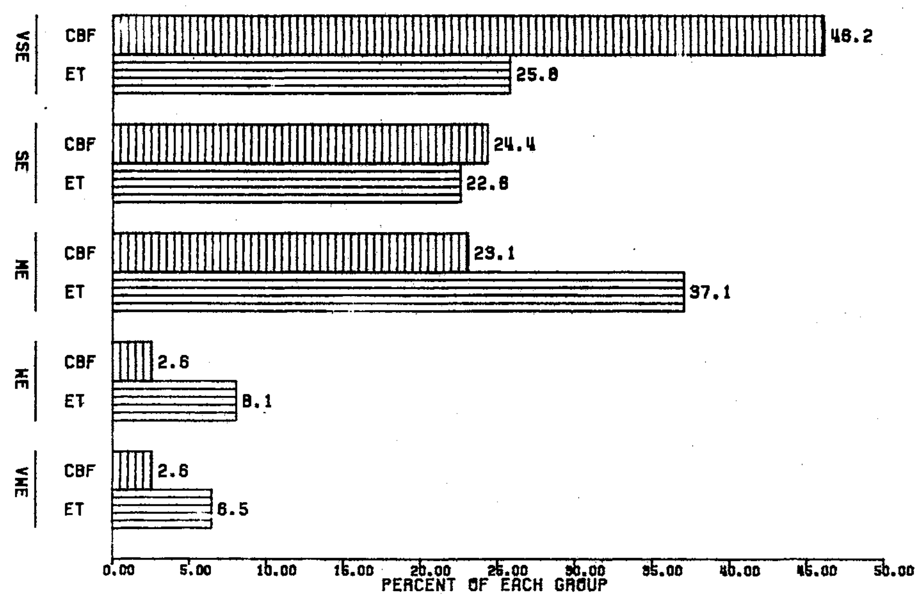

Figure 2. Responses to the Concept That Cell Functions Provide Basic Information About Life Functions at All Biological Levels

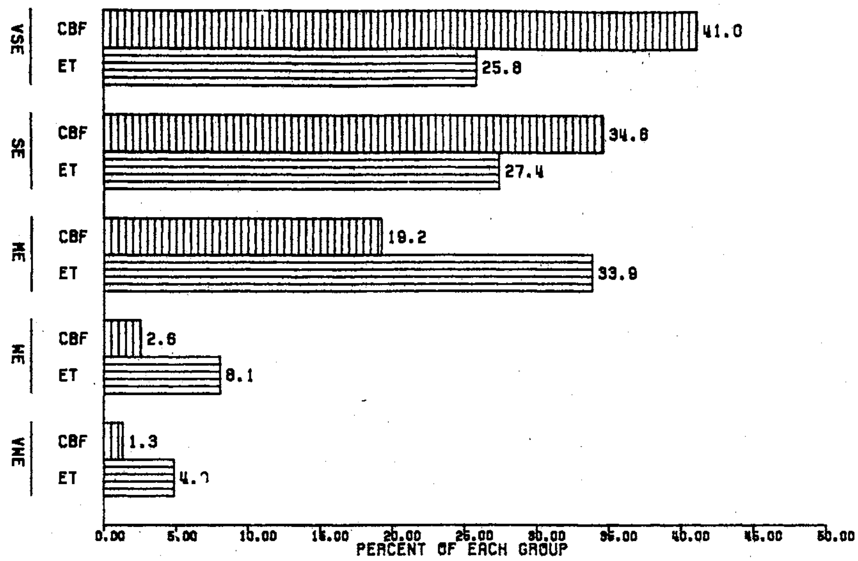

Figure 3. Responses to the Concept That Life Processes are Common to All Living Organisms

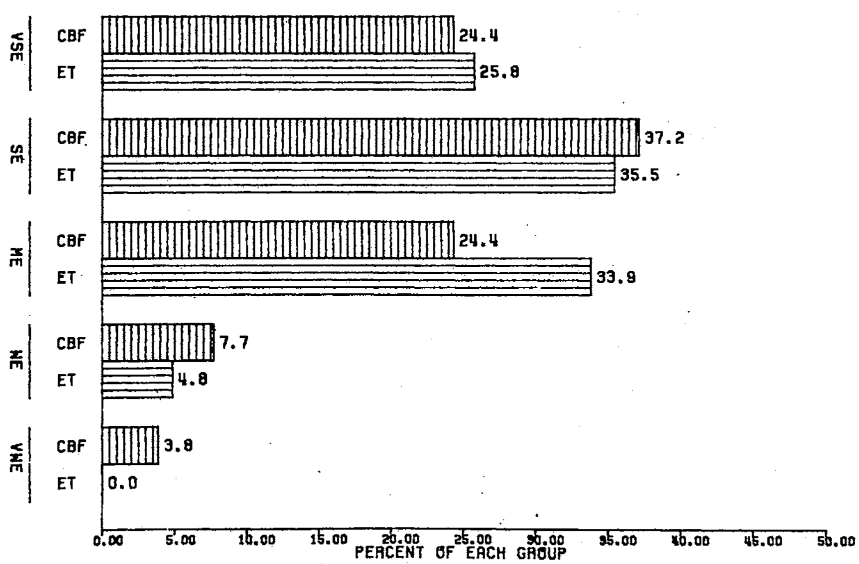

Figure 4. Responses to the Concept That Living Systems Have Four Basic Attributes

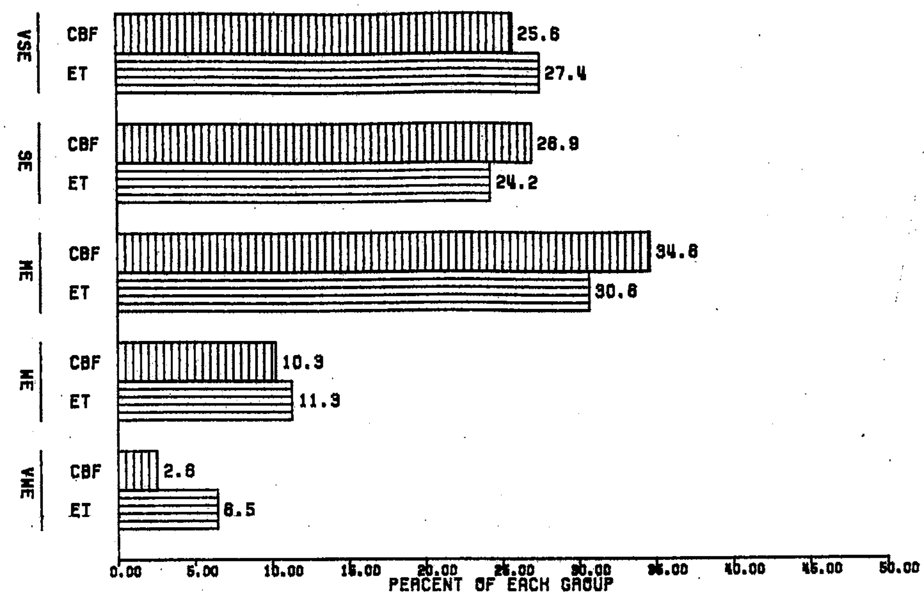

Figure 5. Responses to the Concept That Photosynthesis Results in the Storage of Energy in Chemical Bonds

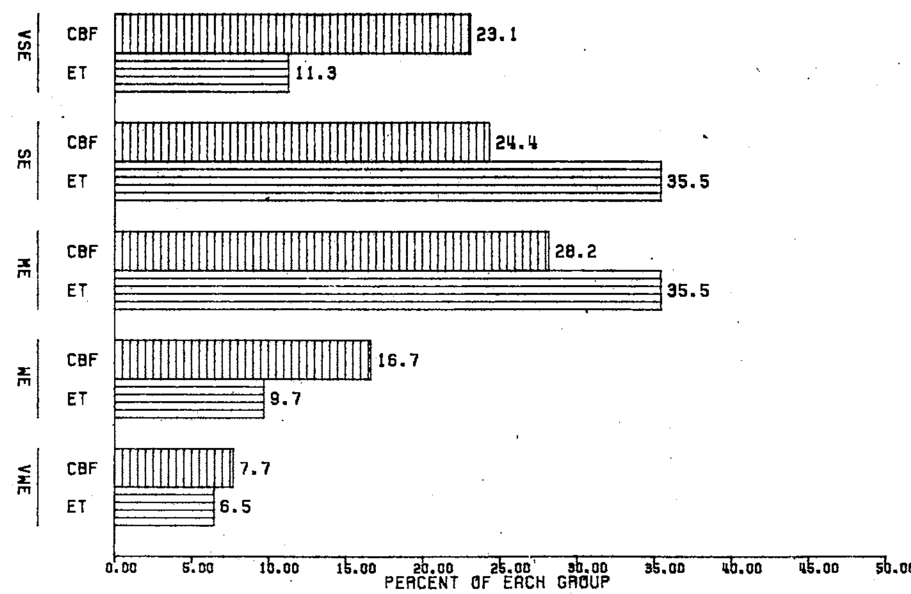

Figure 6. Responses to the Concept That Cellular Respiration Provides Energy in a Form Usable by All Cells

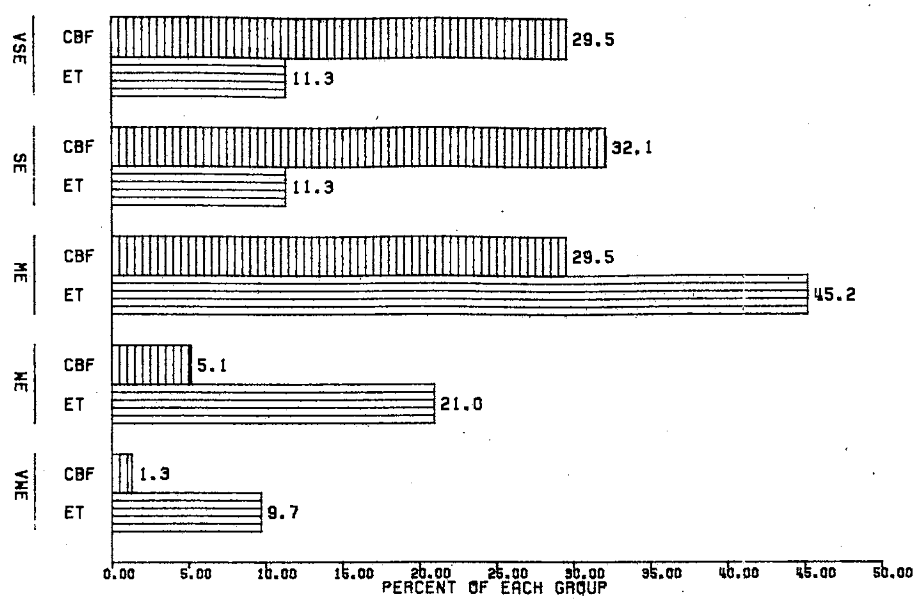

Figure 7. Responses to the Concept That Activities of Living Organisms Result From Chemical and Physical Processes

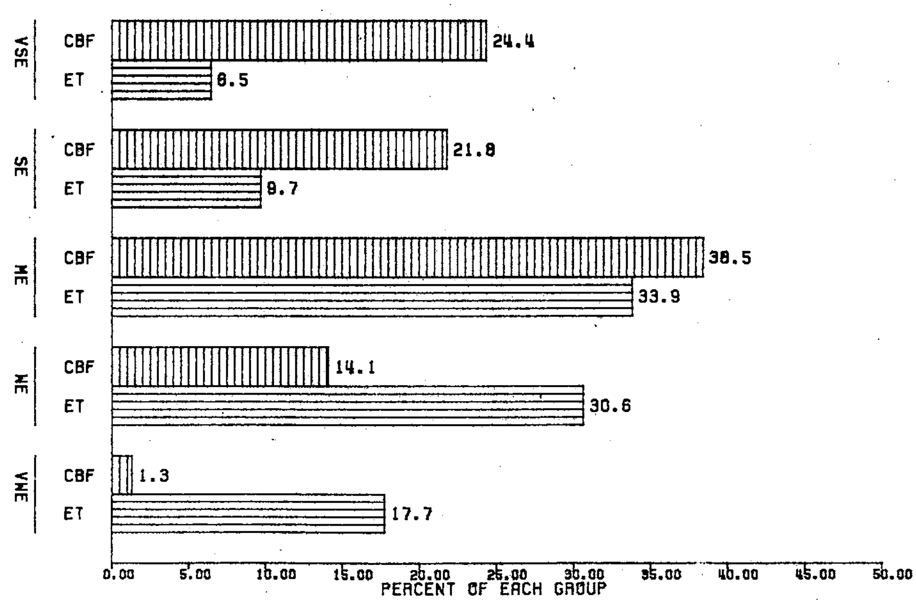

Figure 8. Responses to the Concept That Complex Living Systems are Controlled in Part by Enzymes

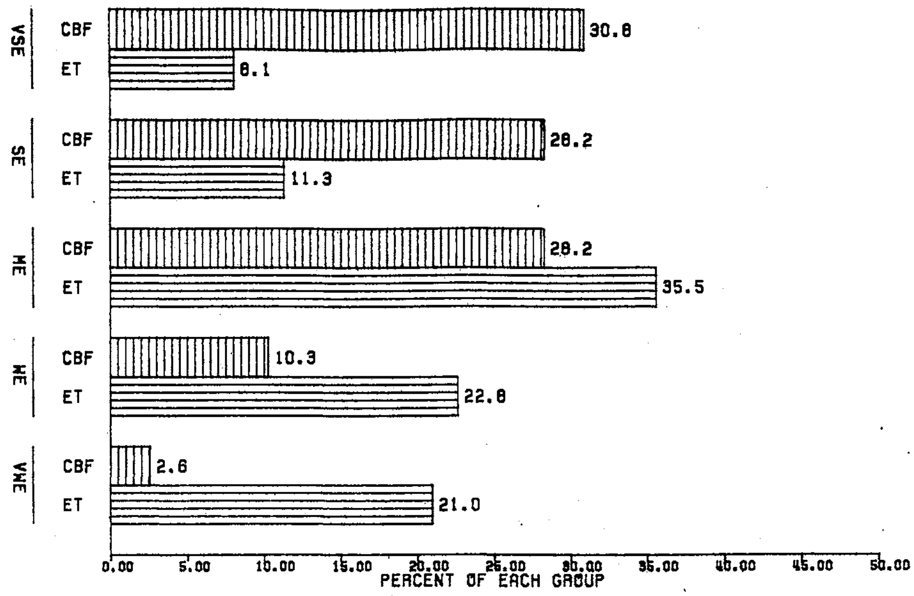

Figure 9. Responses to the Concept That the Universal Genetic Code is Based on Four Different Nucleotides

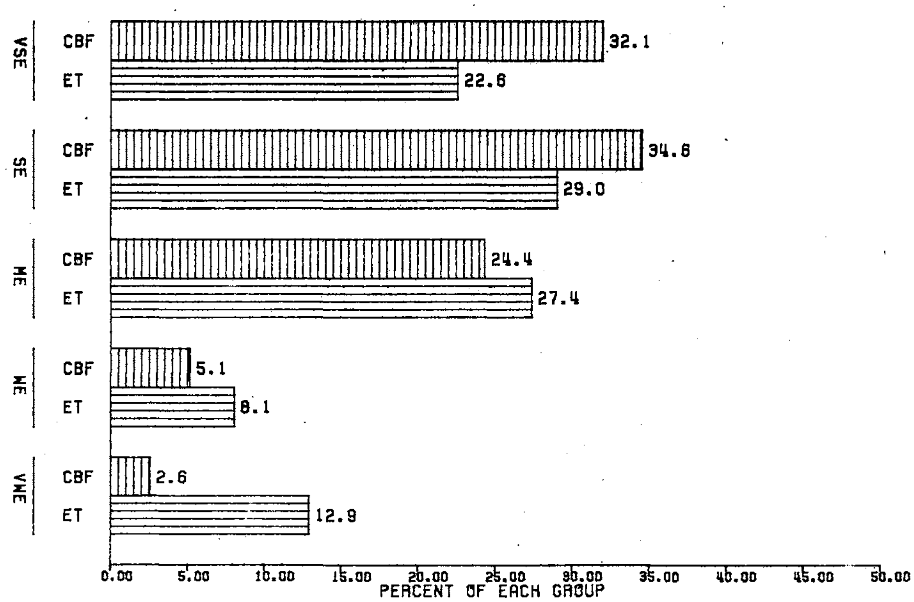

Figure 10. Responses to the Concept That Four Groups of Organic Compounds Form the Basis of All Living Components

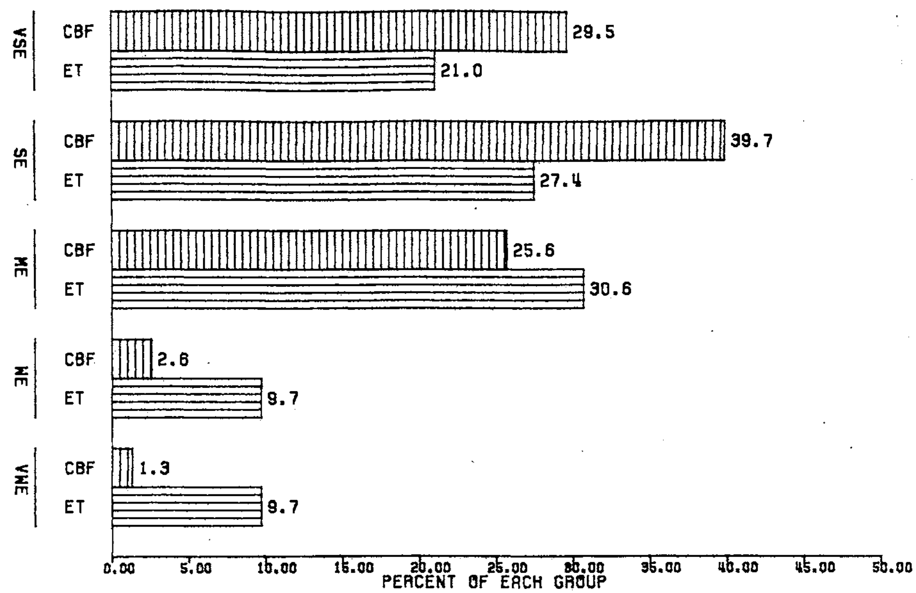

Figure 11. Responses to the Concept That the Gene Consists of DNA and is the Fundamental Unit of Heredity

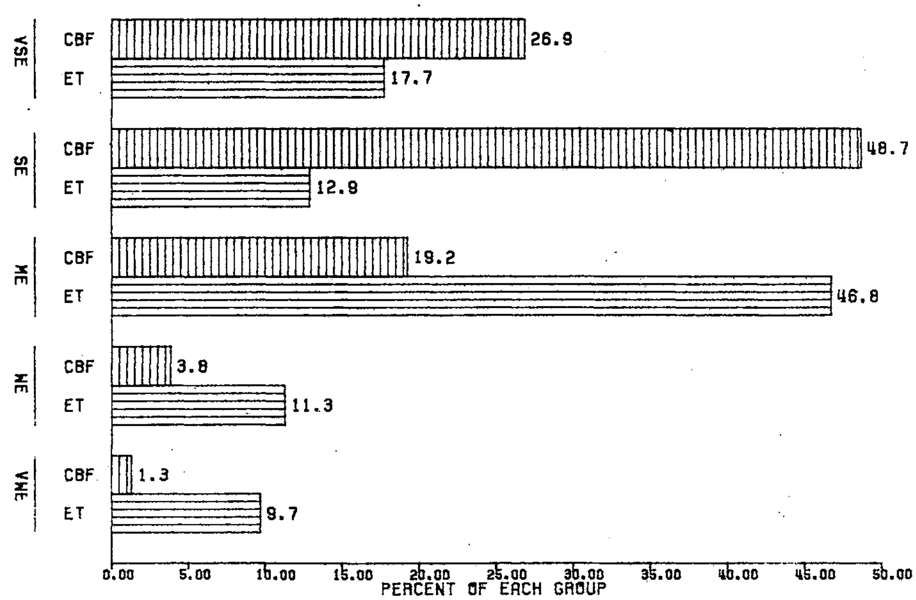

Figure 12. Responses to the Concept That the Basis of Heredity is the Reproduction and Transmission of DNA or RNA

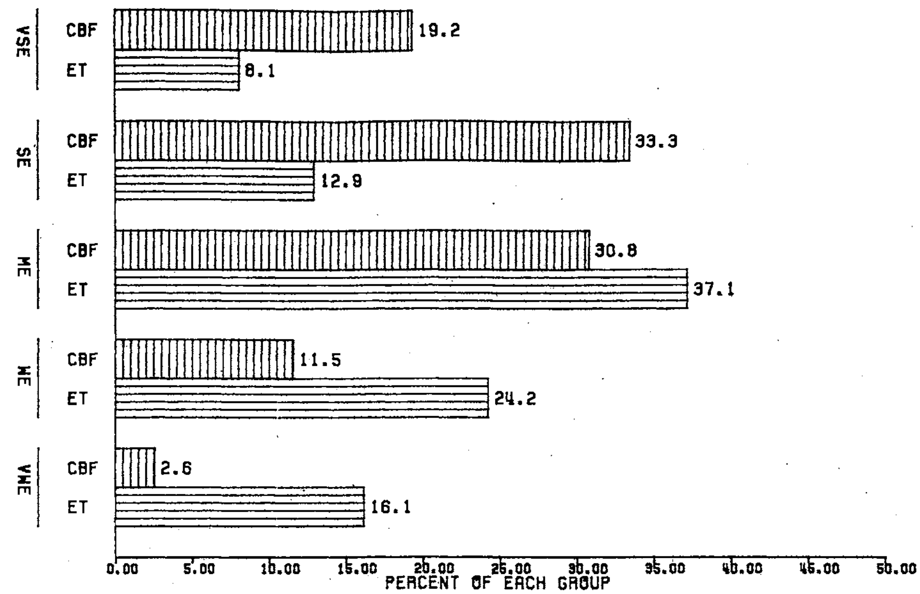

Figure 13. Responses to the Concept That Mutations in a Population are Random; Selection of Mutations Form Patterns

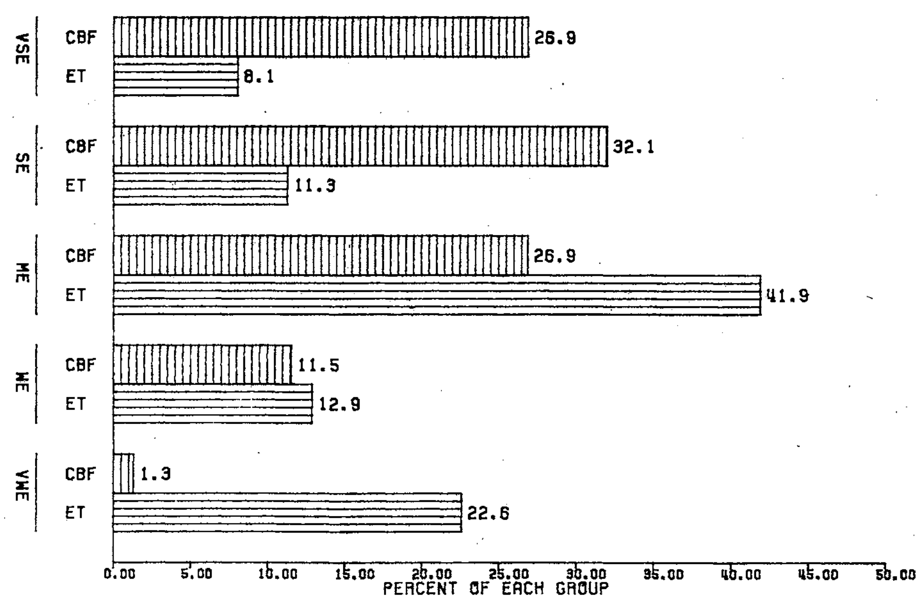

Figure 14. Responses to the Concept That Genetic Material Determines the Properties of Living Organisms

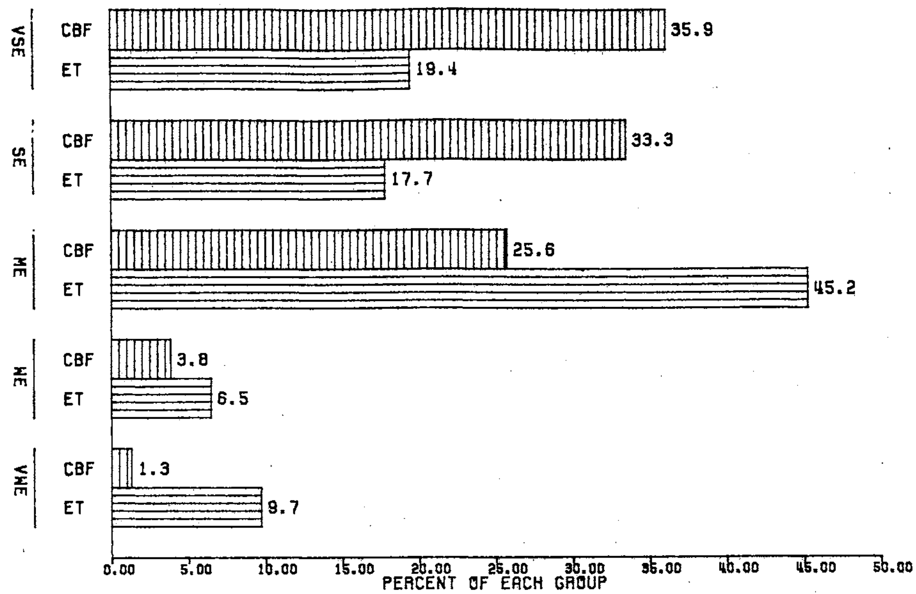

Figure 15. Responses to the Concept That Organisms Reproduce Themselves By Sexual and Asexual Methods

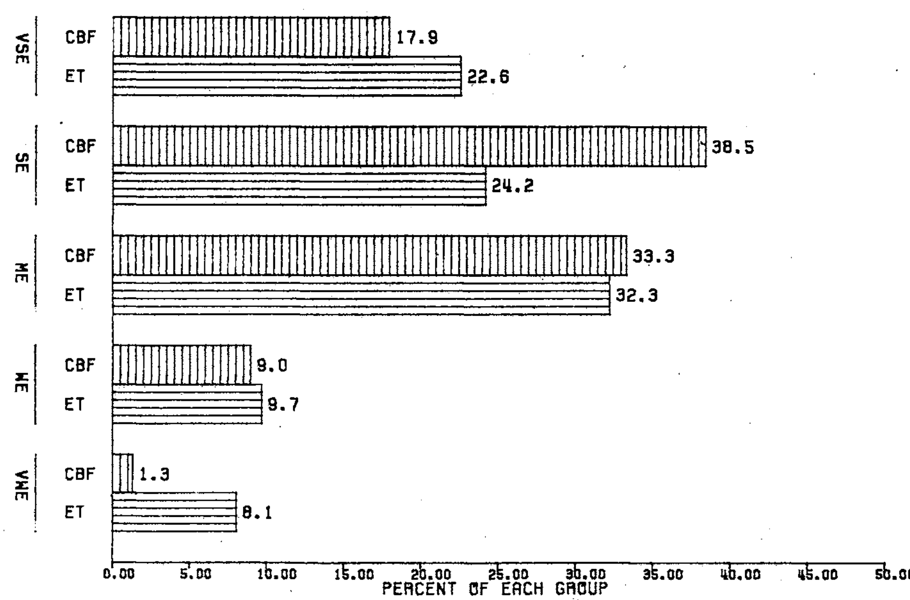

Figure 16. Responses to the Concept That Adaptation Has Resulted in Biological Organization

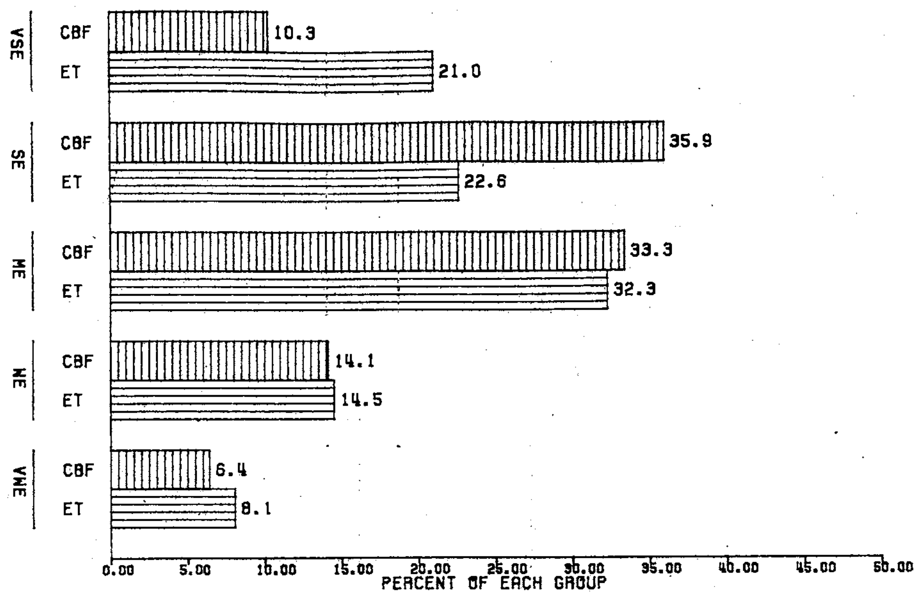

Figure 17. Responses to the Concept That the Animal Kingdom Can Be Sub-divided into Vertebrates and Invertebrates

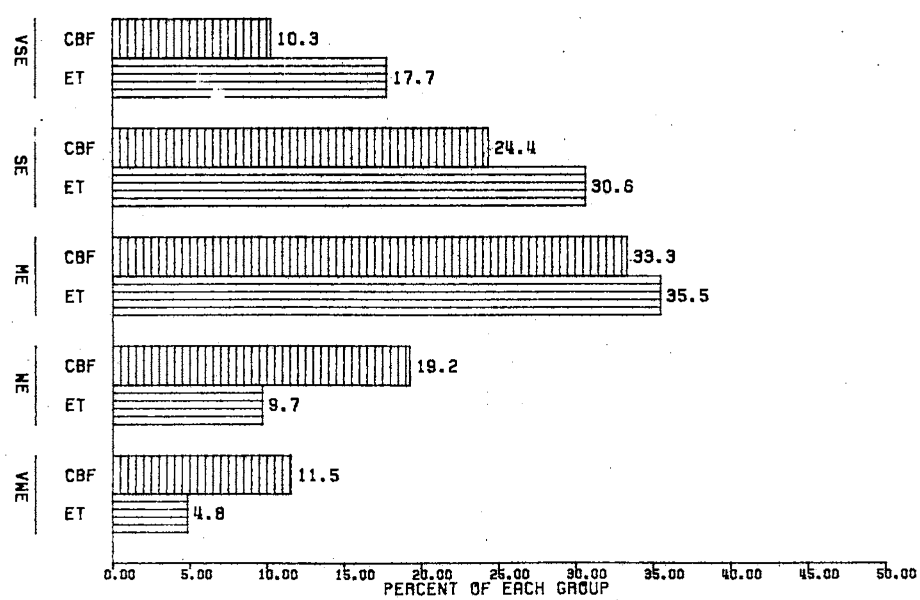

Figure 18. Responses to the Concept That There are Groups of Plants Important to Man: the Gymnosperms and Angiosperms

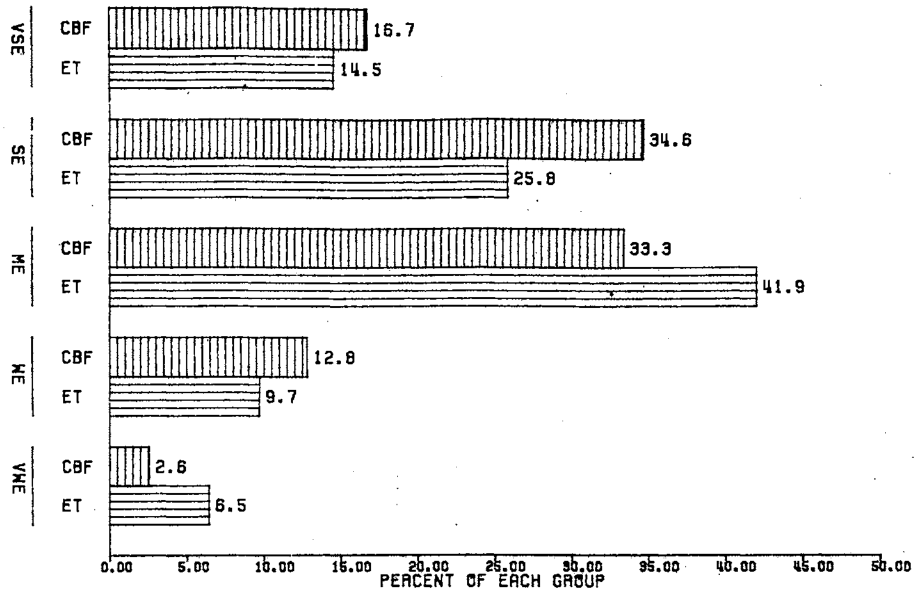

Figure 19. Responses to the Concept That One Cell Organisms Perform All the Basic Functions of Life

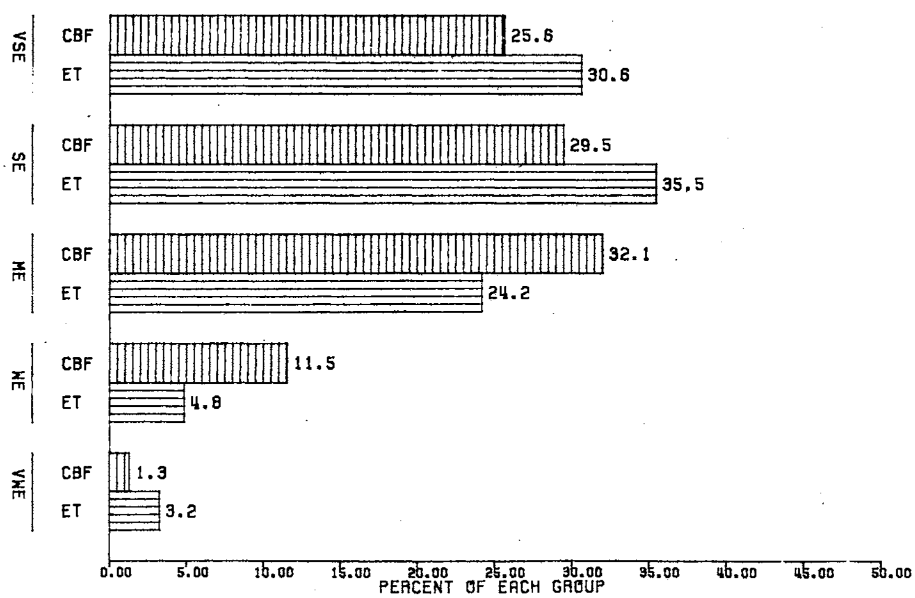

Figure 20. Responses to the Concept That Some Life Processes are Shared by All Higher Animals

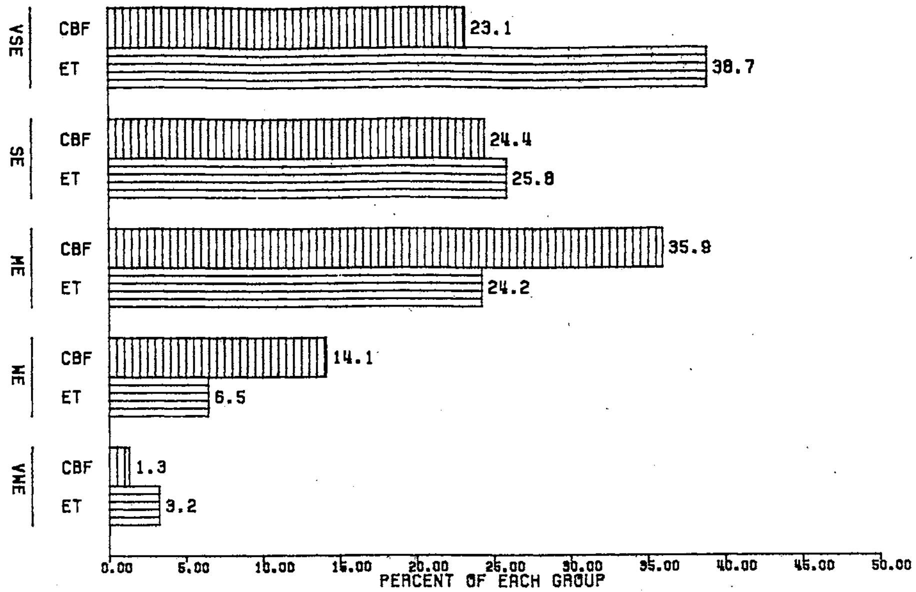

Figure 21. Responses to the Concept That There are Certain Basic Life Processes Shared by All Higher Plants

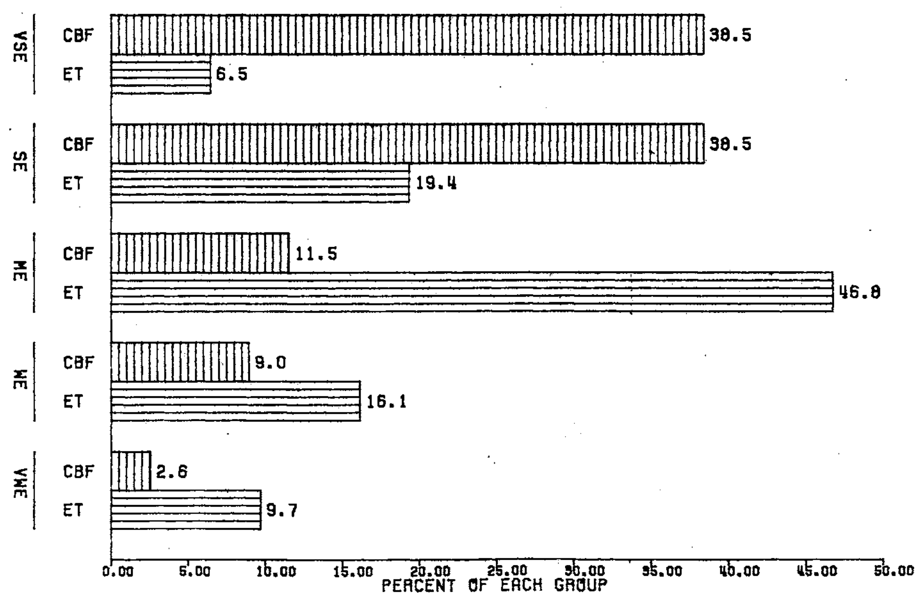

Figure 22. Responses to the Concept That All Living Systems are Actively Engaged in Maintaining Homeostasis

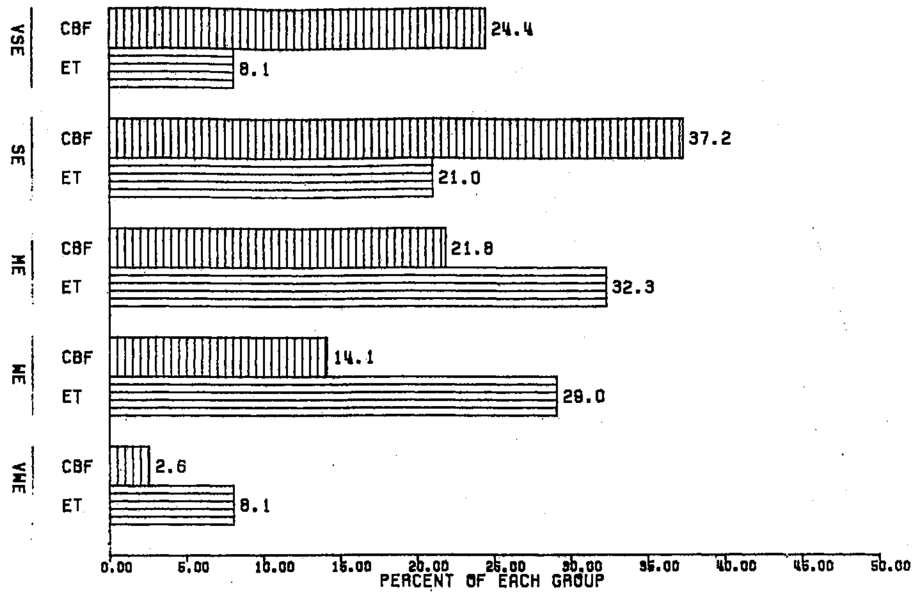

Figure 23. Responses to the Concept That Feedback Systems Help Regulate the Activities of Living Systems

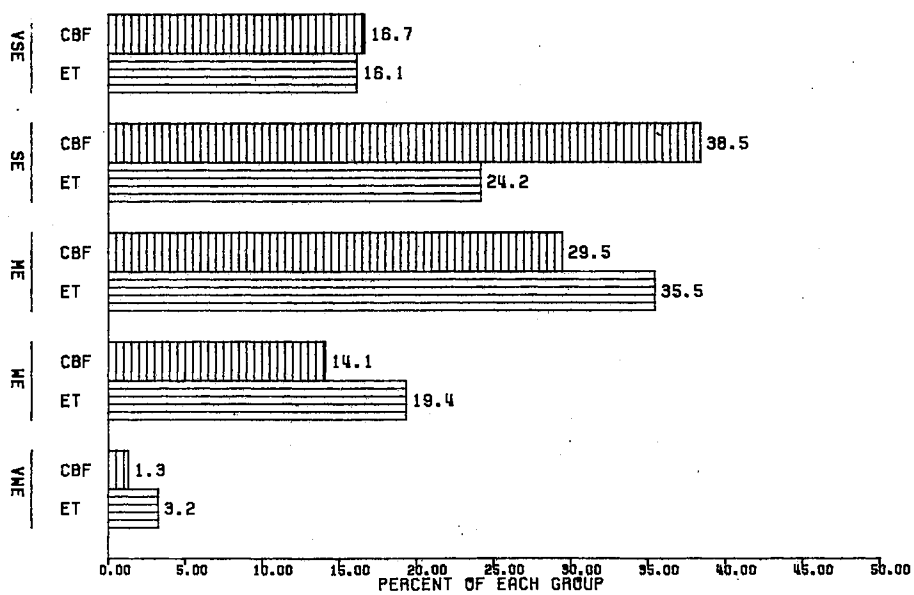

Figure 24. Responses to the Concept That the Development of an Organism Results From an Interaction With Its Environment

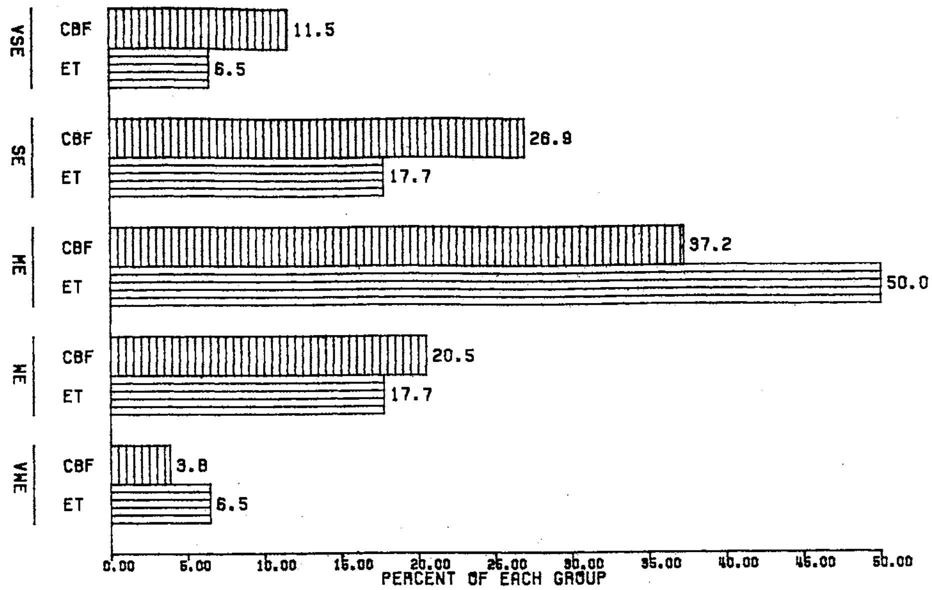

Figure 25. Responses to the Concept That as a Zygote Develops It Loses Part of Its Ability to Differentiate

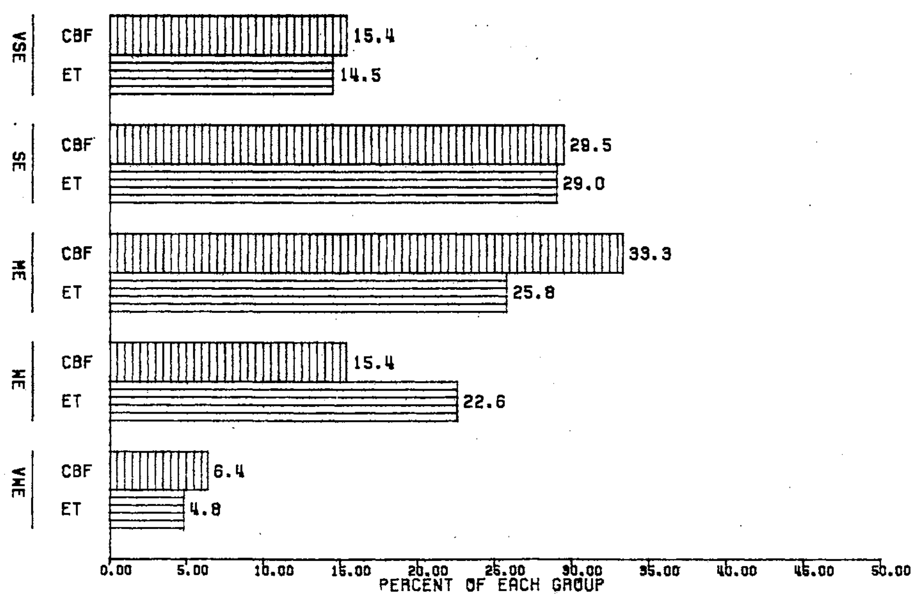

Figure 26. Responses to the Concept That Animal Behavior Has Evolved Just as Other Biological Processes Have

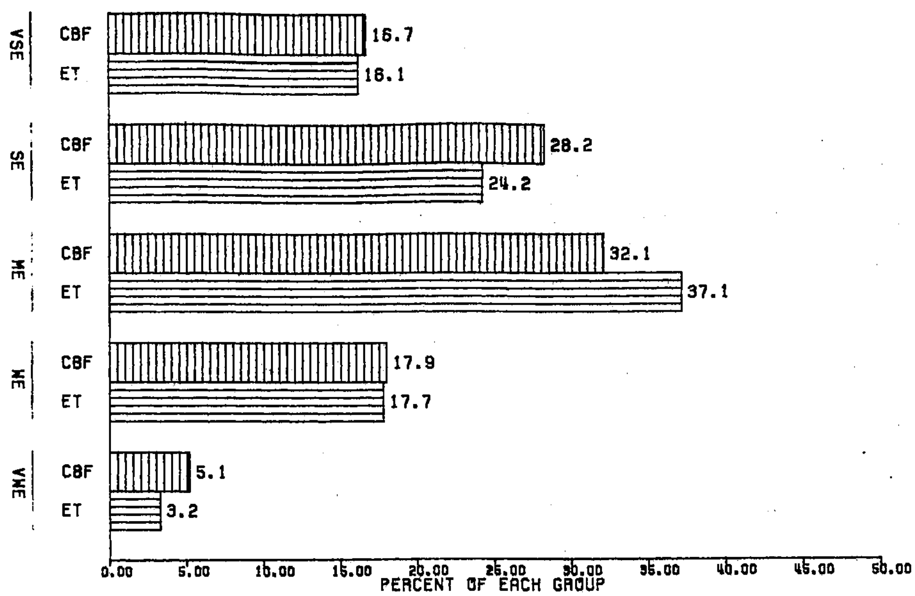

Figure 27. Responses to the Concept That Most Microorganisms are Essential Components of the Ecosystem

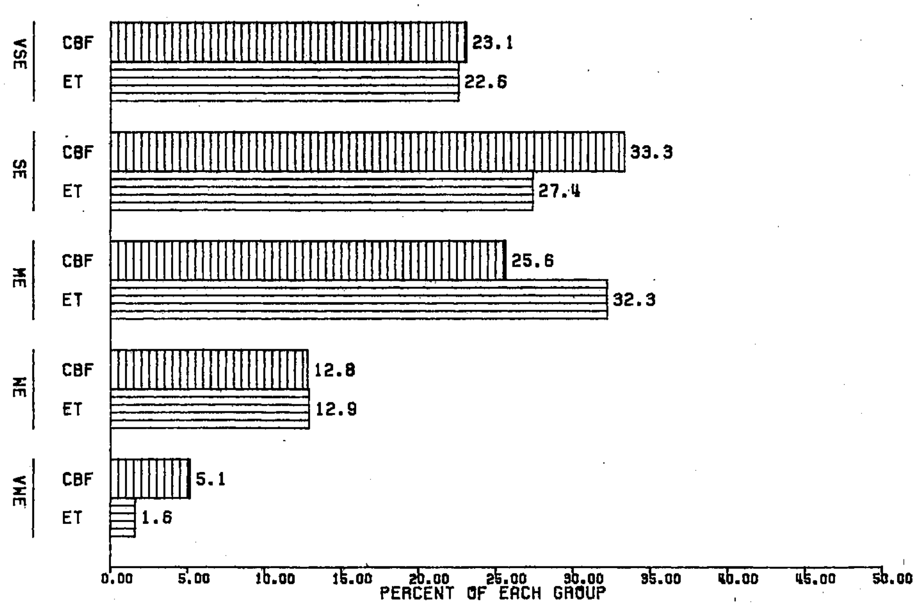

Figure 28. Responses to the Concept That Plant and Animal Pests Can Best Be Controlled By Natural Means

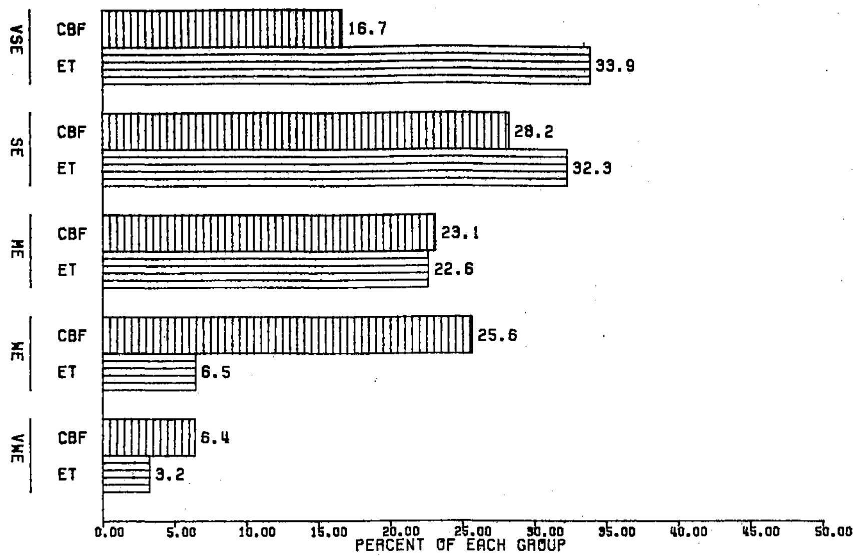

Figure 29. Responses to the Concept That Diseases are Ideally Controlled By Prevention Rather Than Cure

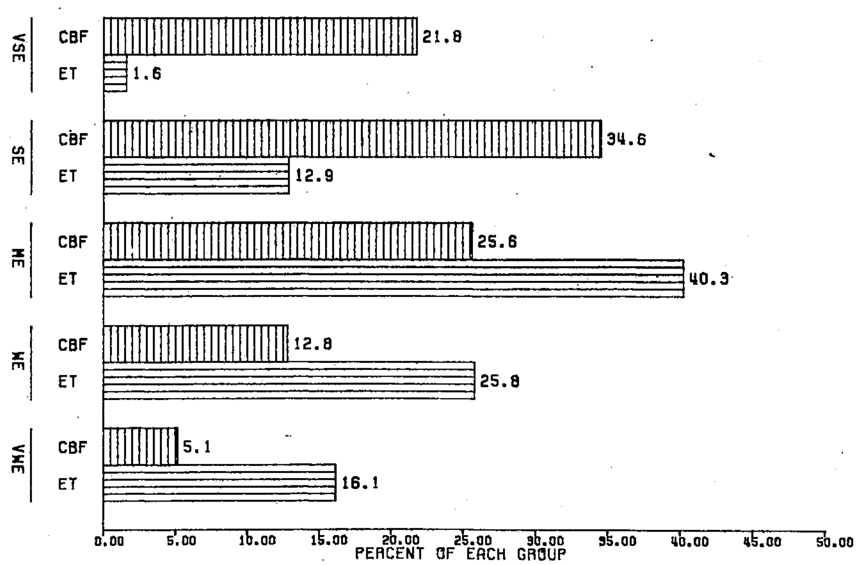

Figure 30. Responses to the Concept That the Biological Patterns of Diversity are the Results of Evolution

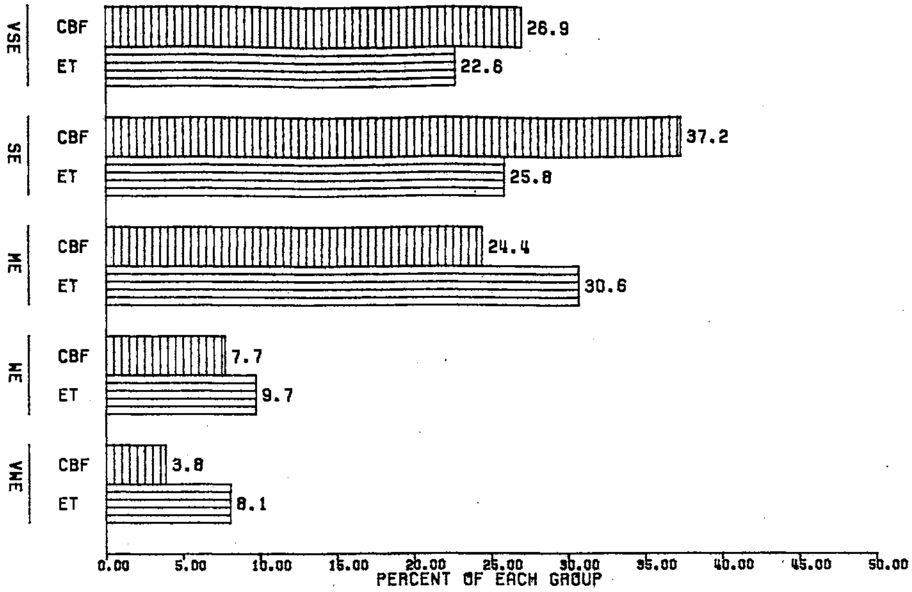

Figure 31. Responses to the Concept That Change is a Natural Phenomenon: All Things Change Through Time

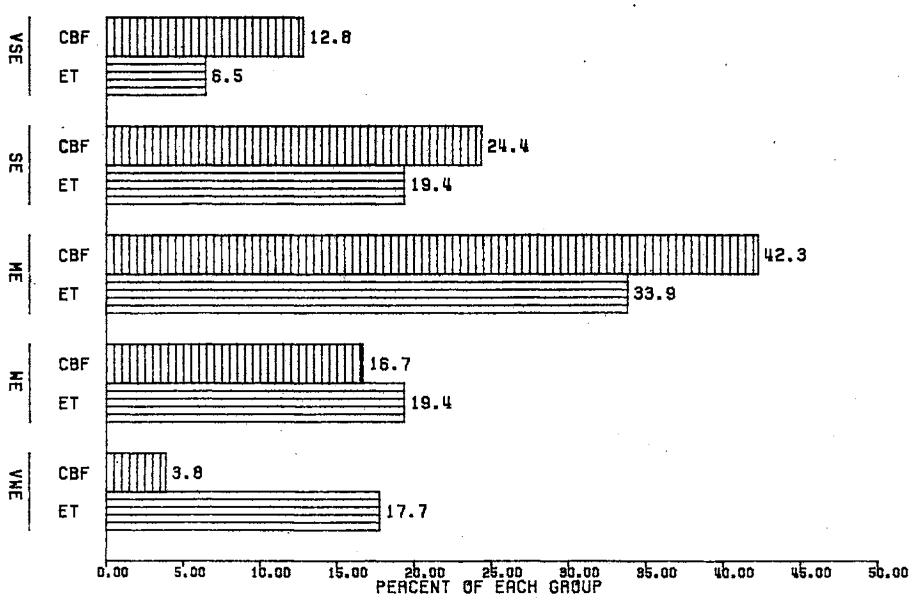

Figure 32. Responses to the Concept That No Single Characteristic Separates Plants From Animals

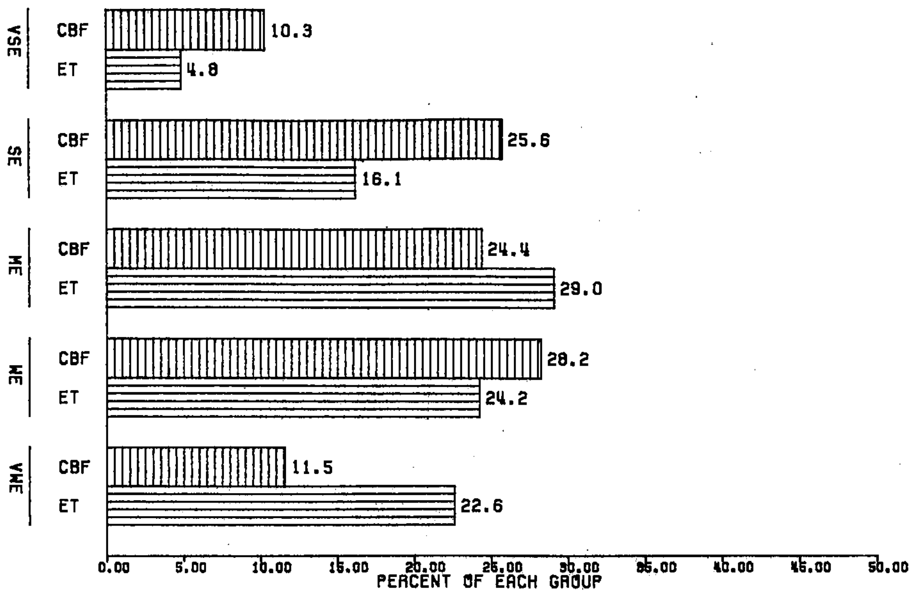

Figure 33. Responses to the Concept That Life May Have Begun Spontaneously in a Primitive Environment

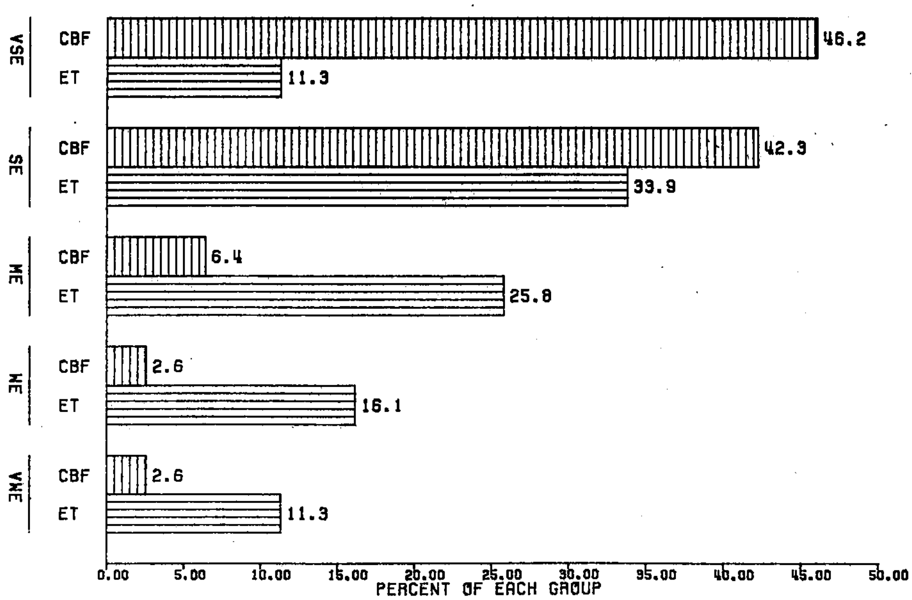

Figure 34. Responses to the Concept That the Living World is Made of Ecosystems

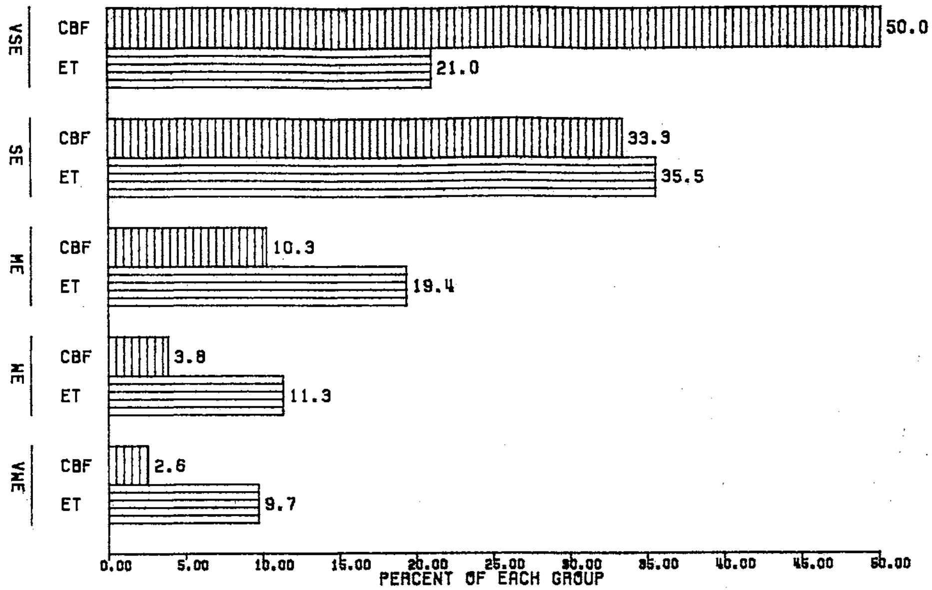

Figure 35. Responses to the Concept That Energy Has a Unidirectional Flow Through Ecosystems

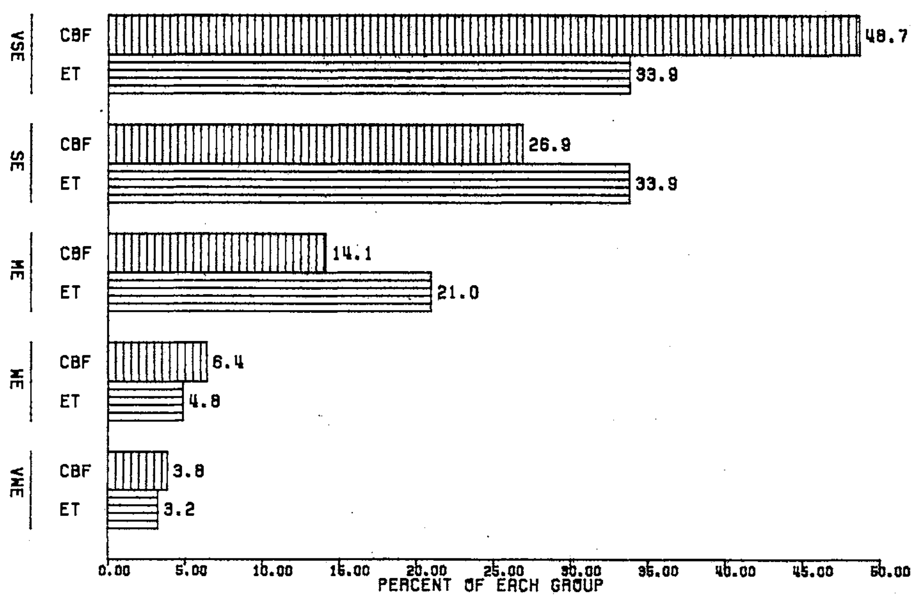

Figure 36. Responses to the Concept That the Earth Has Finite Space, Material and Available Energy

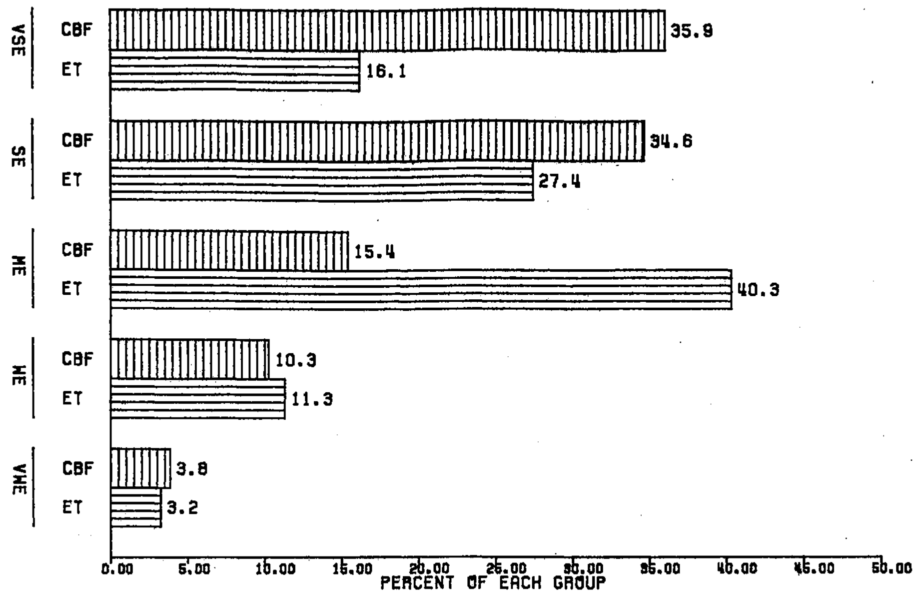

Figure 37. Responses to the Concept That Order is a Constant Theme in Biology

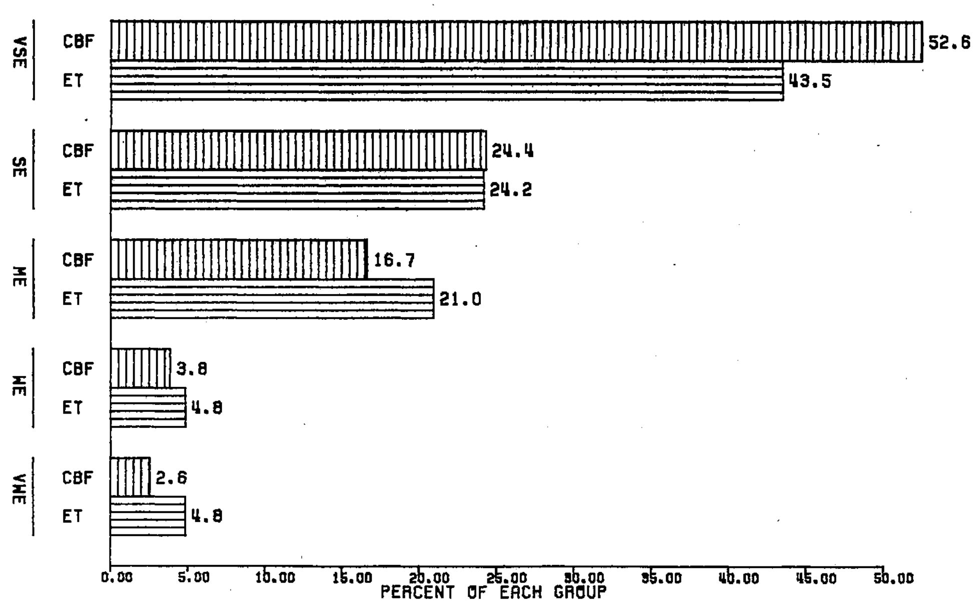

Figure 38. Responses to the Concept That Man is a Powerful Ecological Force

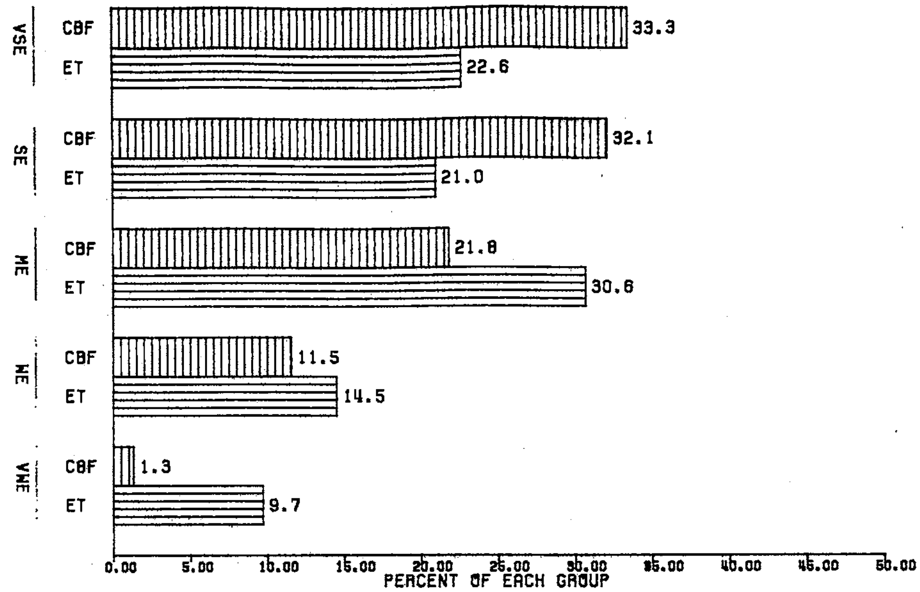

Figure 39. Responses to the Concept That Population Growth is Related to Reproduction and Migration

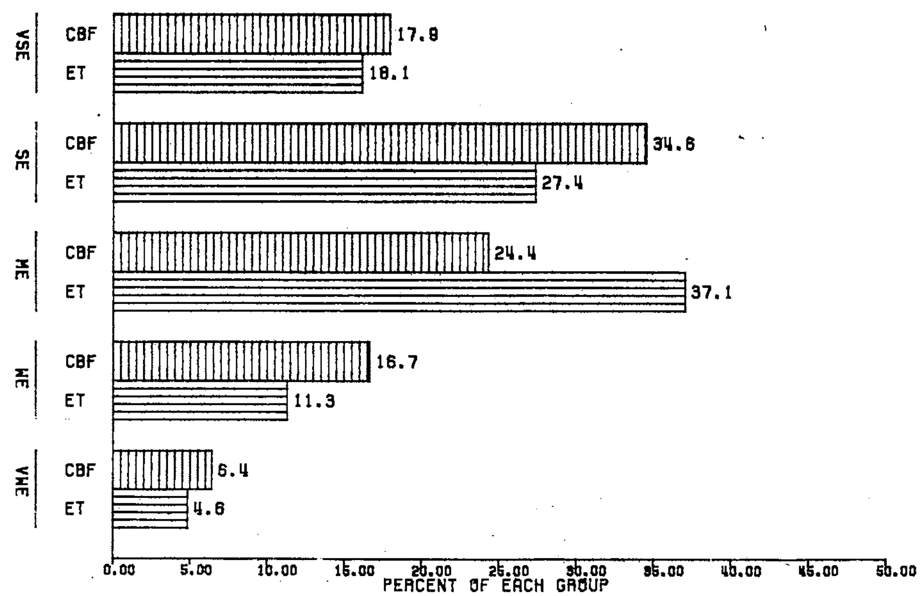

Figure 40. Responses to the Concept That Man's Social Interaction Has a Basic Biological Behavioral Pattern

The following 35 graphs relate to the methodology portion of the opinionnaire and are labeled to correspond with the rank order scale on the opinionnaire as follows: strongly agree (SA); agree (A); undecided (U); disagree (D); strongly disagree (SD).

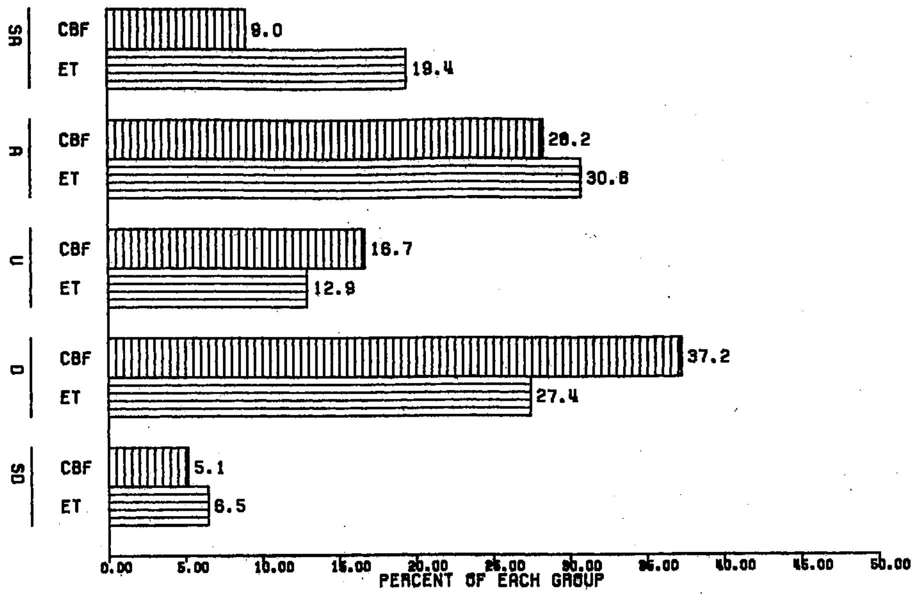

Figure 41. A General Education Biology Course Should Teach Fewer Topics and Teach Them in Depth

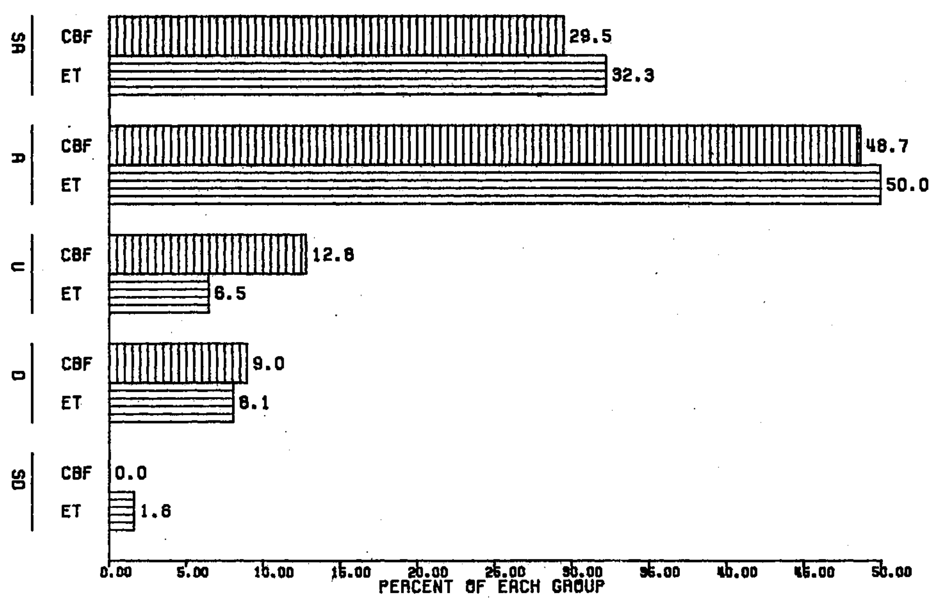

Figure 42. A General Education Biology Course Should Place Increased Emphasis on the Social Implications of Biology

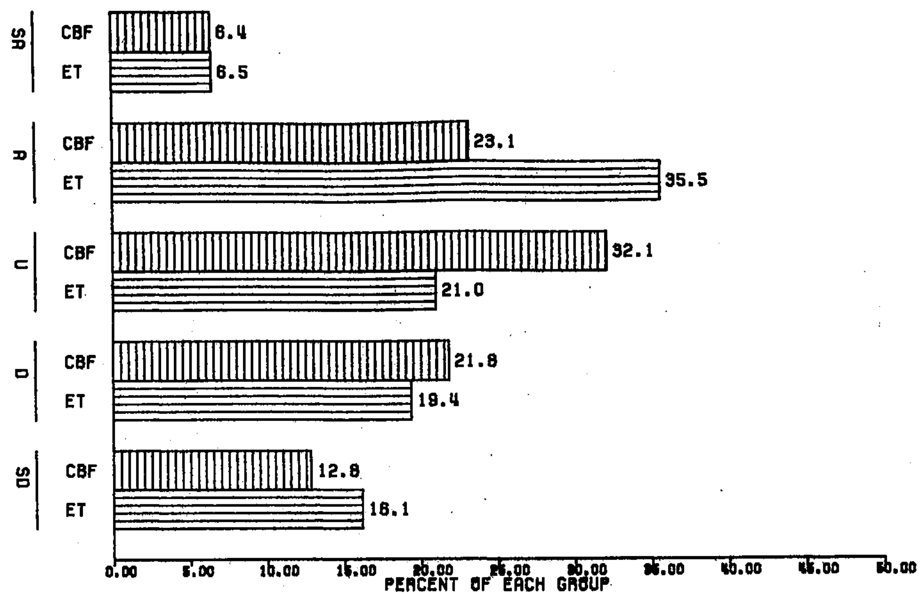

Figure 43. A General Education Biology Course Should Give Students an Opportunity to Analyze Statistical Data

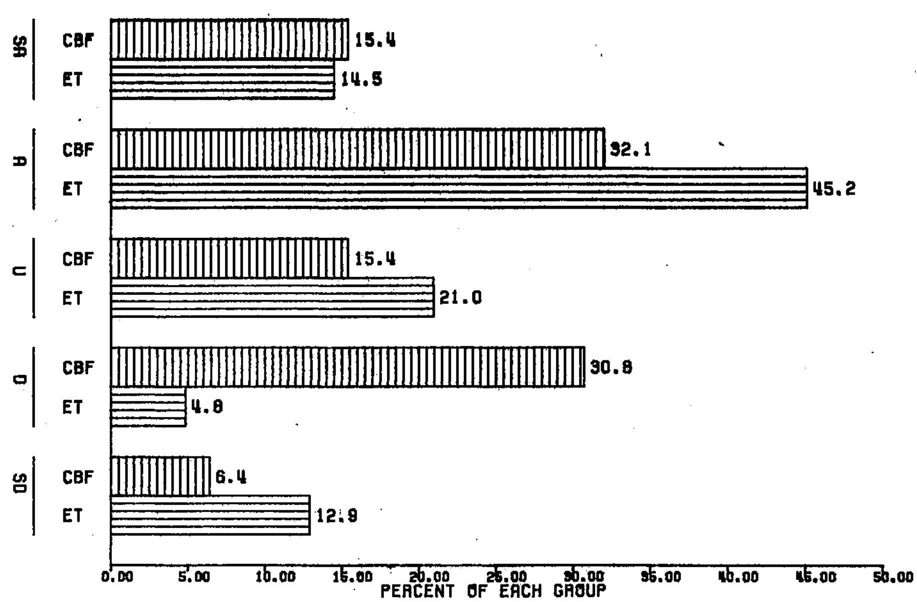

Figure 44. A General Education Biology Course Should Include Science Majors as Well as Nonmajors

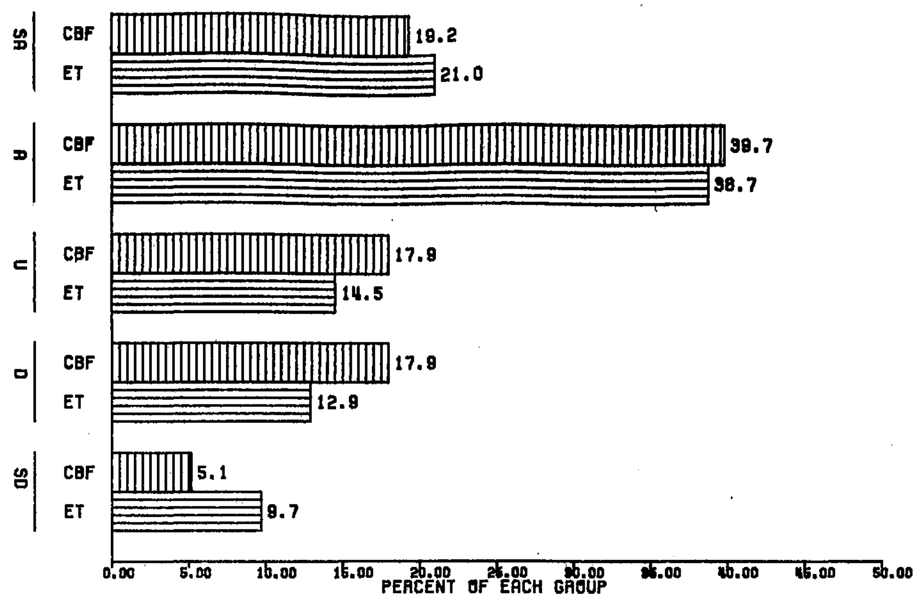

Figure 45. A General Education Biology Course Should Be Centered Around Laboratory Work

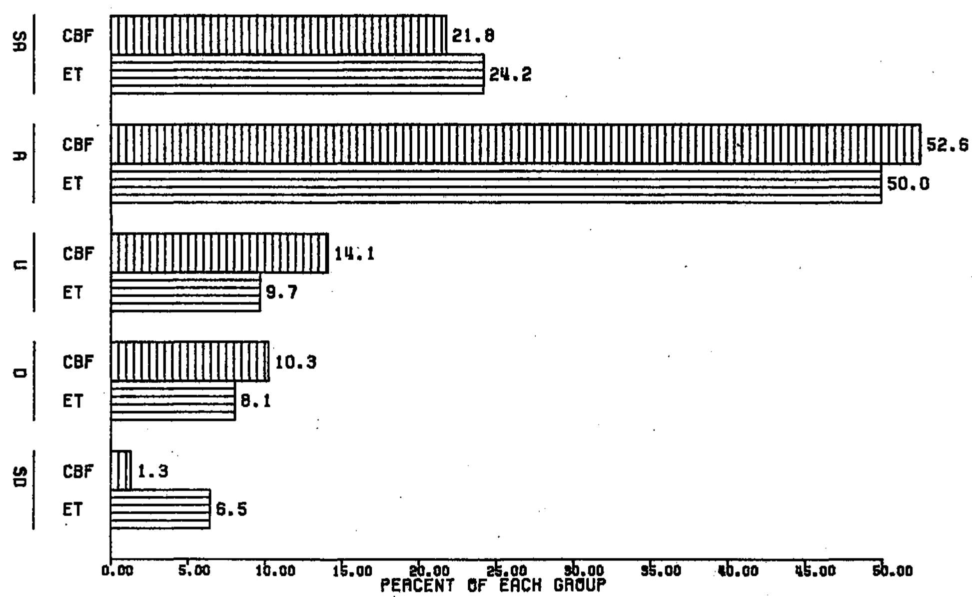

Figure 46. A General Education Biology Course Should Include the Basic Rules of Scientific Research

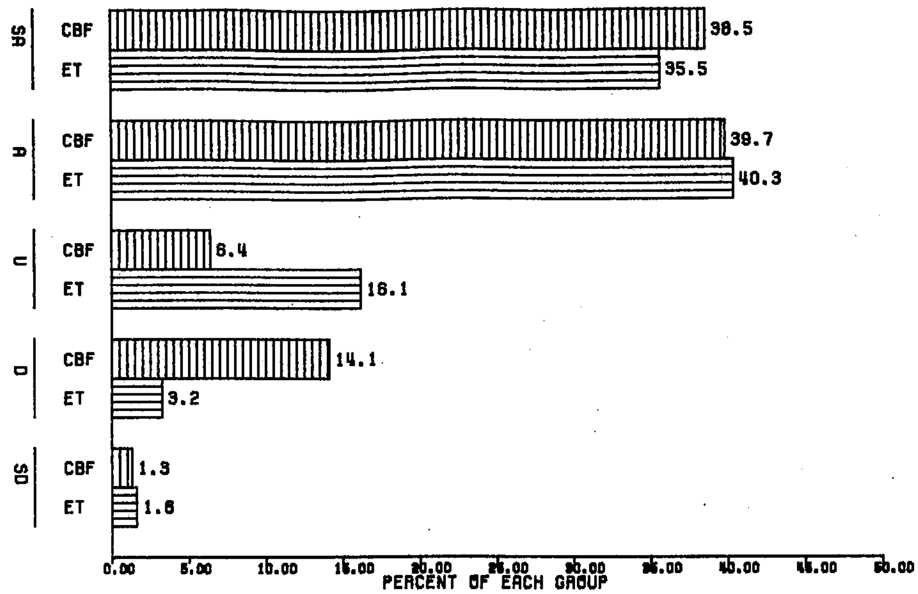

Figure 47. A General Education Biology Course Should be Comprehensive

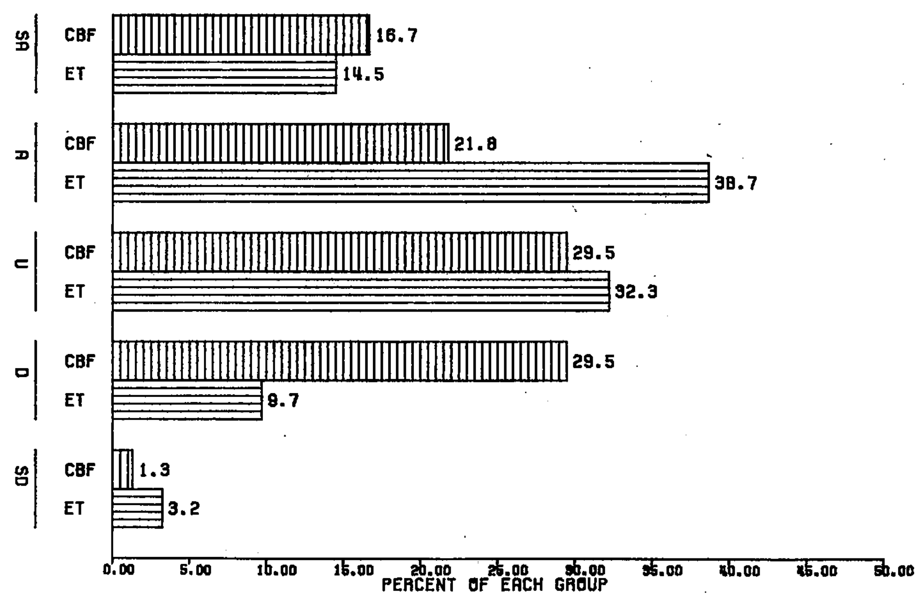

Figure 48. A General Education Biology Course Should Be Taught By the Inquiry Method

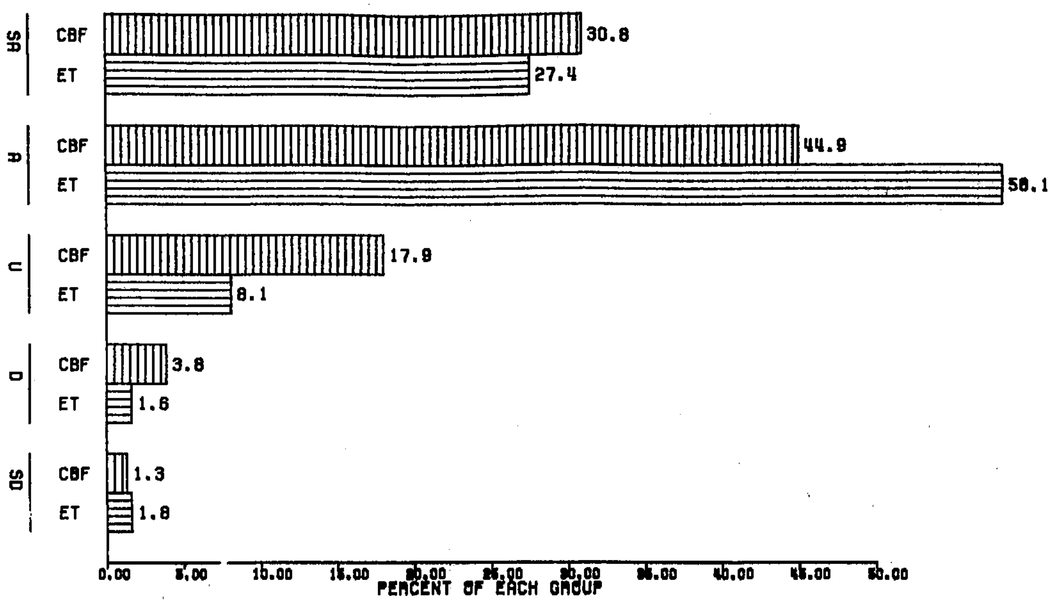

Figure 49. A General Education Biology Course Should Have Well Defined Behavioral Objectives Both in the Classroom and Laboratory

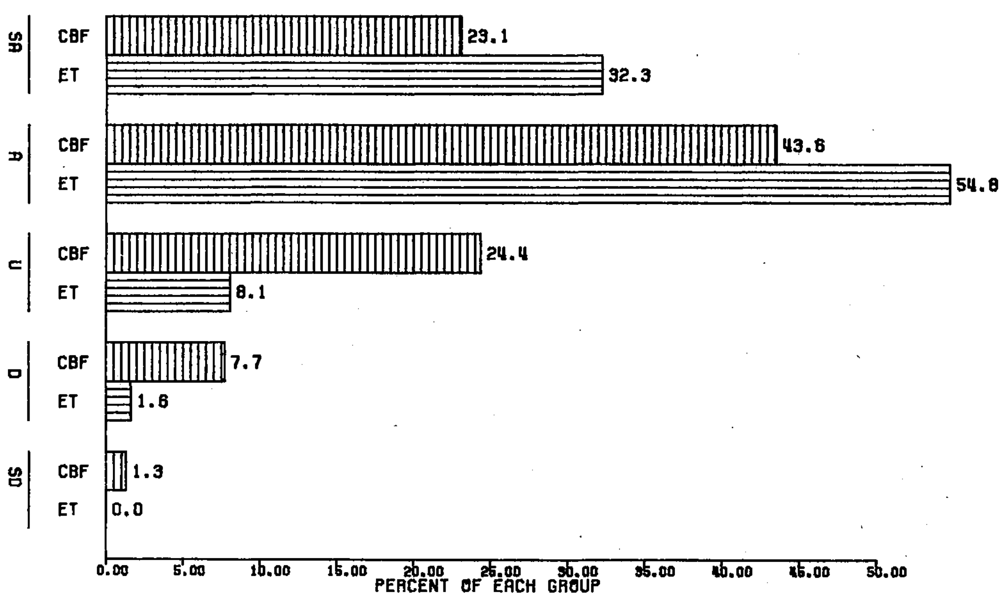

Figure 50. A General Education Biology Course Should Have Definite Provisions For Individual Study

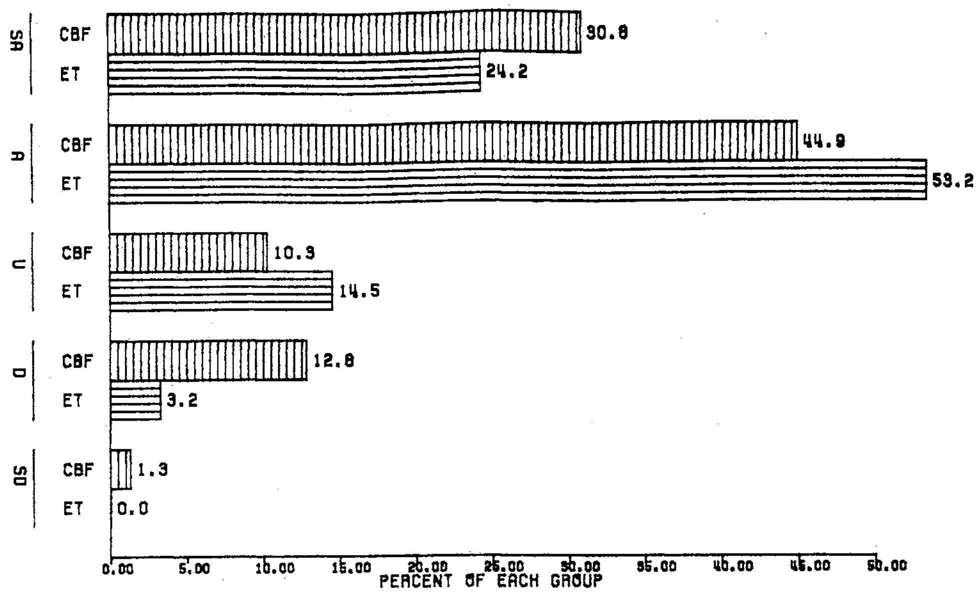

Figure 51. A General Education Biology Course Should Have a Regular Laboratory Period Which is Coordinated With Classroom Lectures

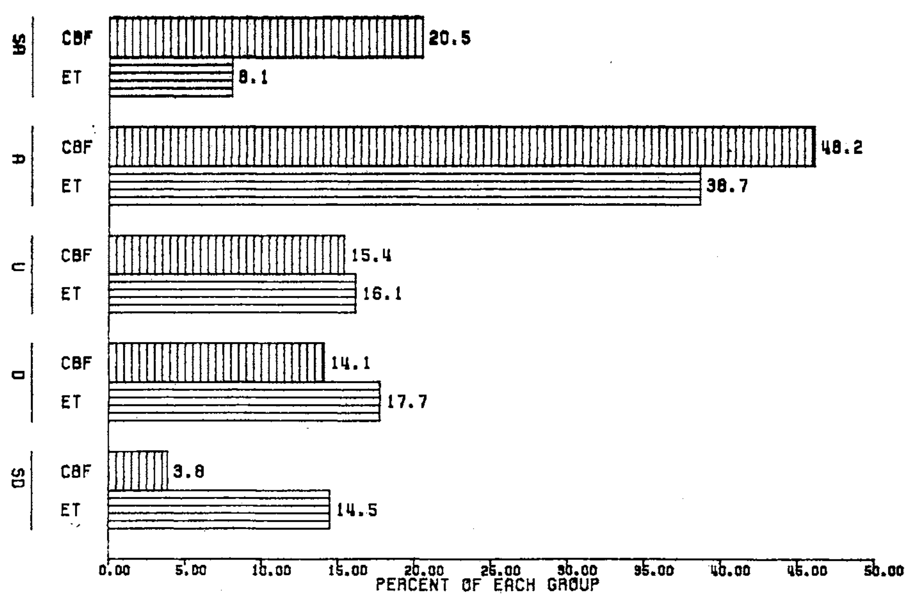

Figure 52. A General Education Biology Course Should Have a Comprehensive Examination at the End of the Semester

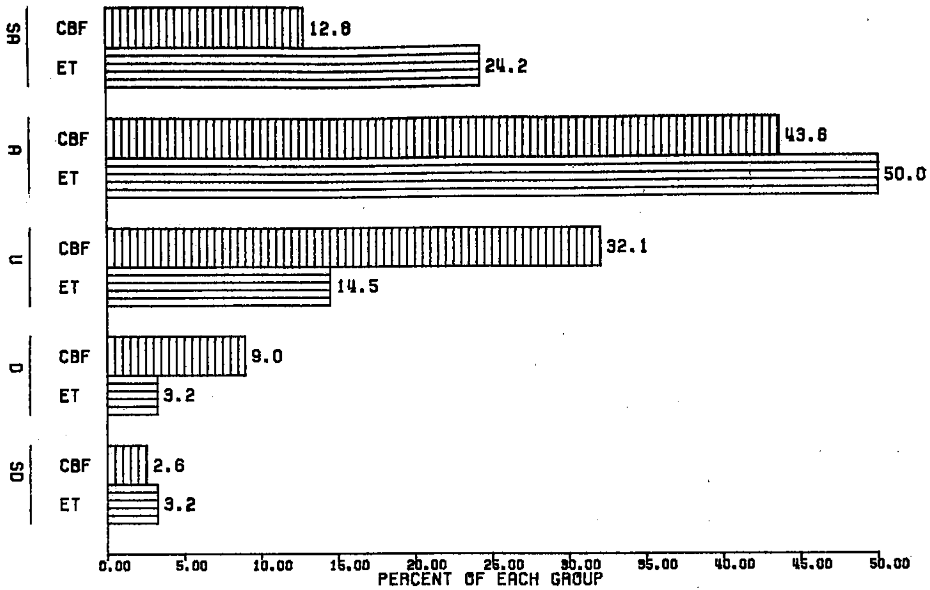

Figure 53. A General Education Biology Course Should Include Some Group Study Problems

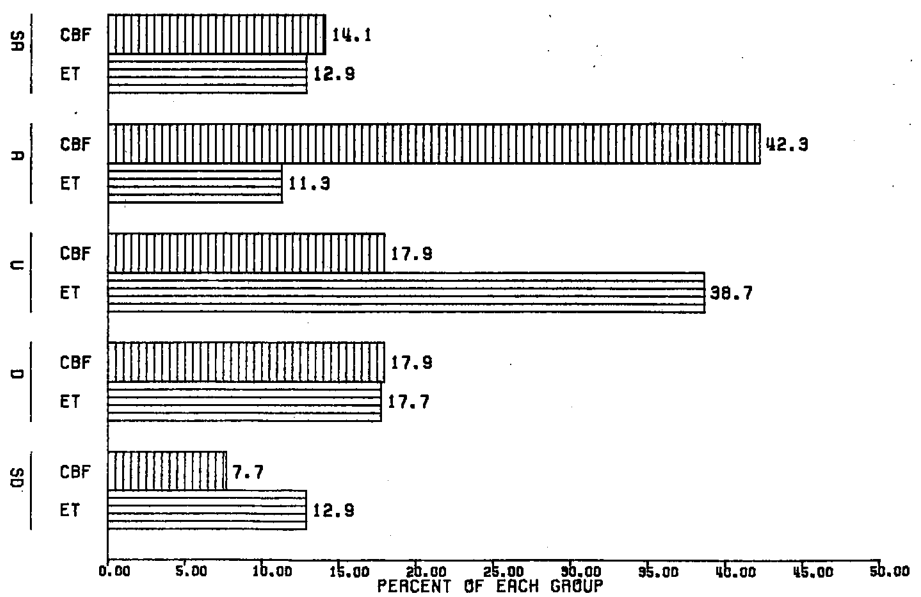

Figure 54. A General Education Biology Course Should Be a One Semester Course

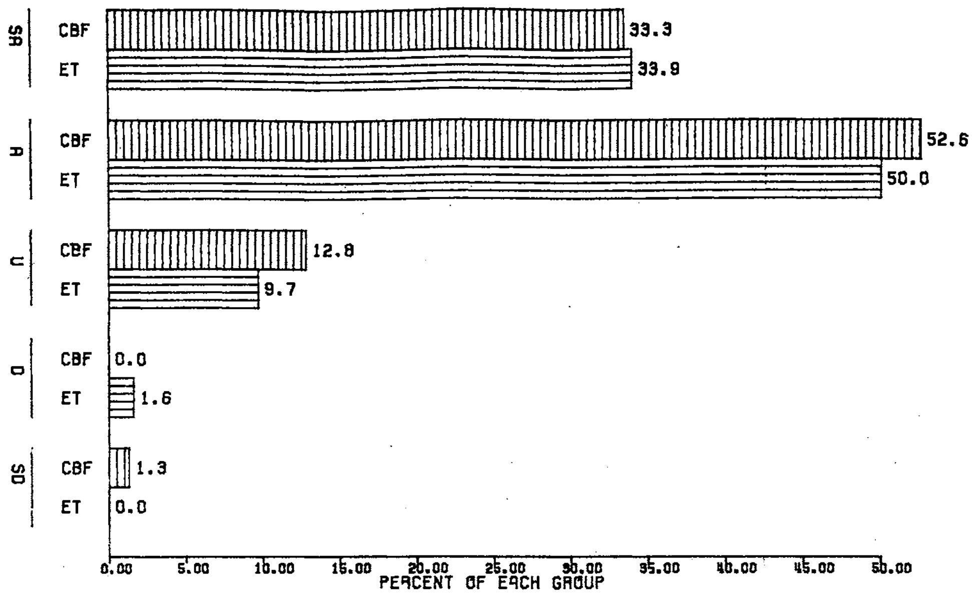

Figure 55. A General Education Biology Course Should Have Provisions for a Student Study Area

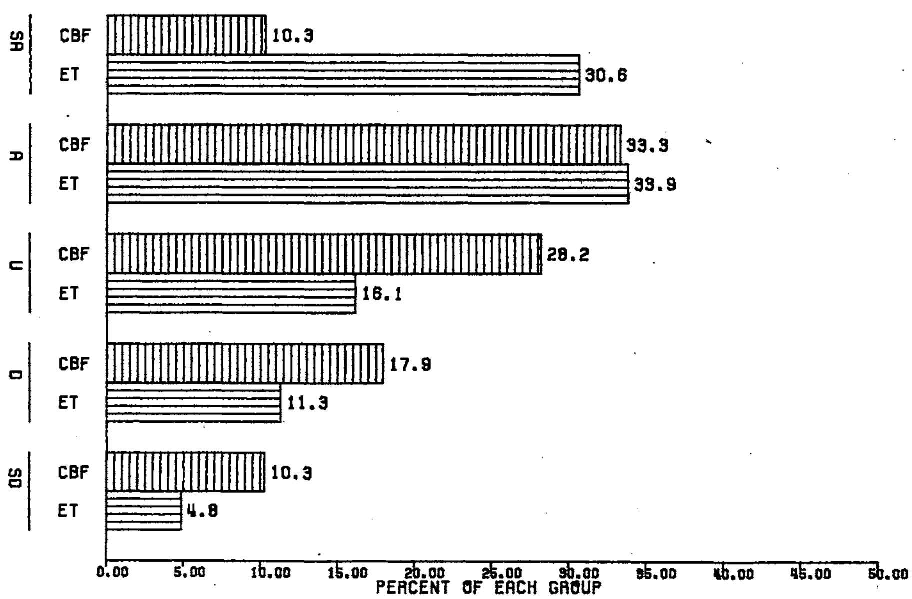

Figure 56. A General Education Biology Course Should Give the Student a List of Specific Class Performances Required for an A, B, Etc.

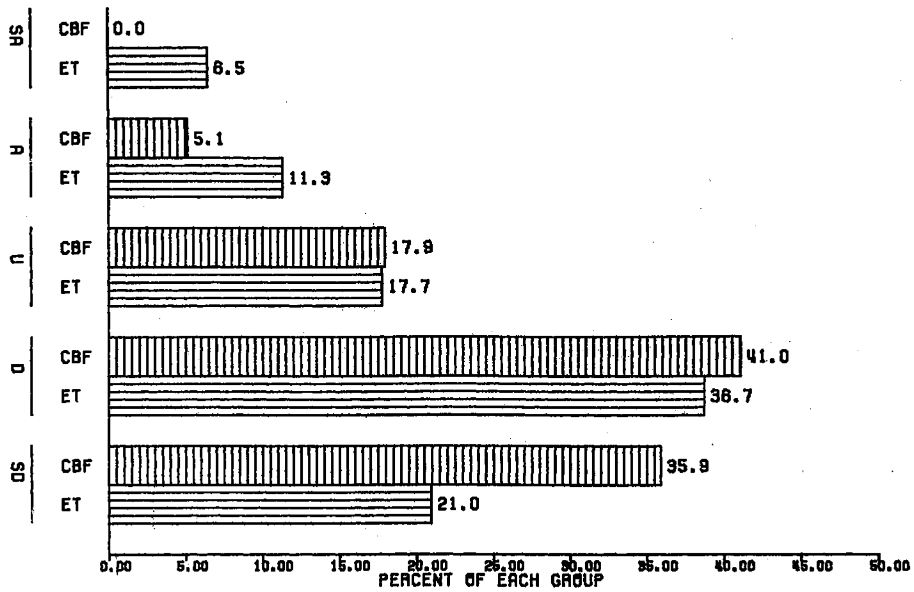

Figure 57. A General Education Biology Course Should Omit the Laboratory in Favor of Films, Slides and Classroom Demonstrations

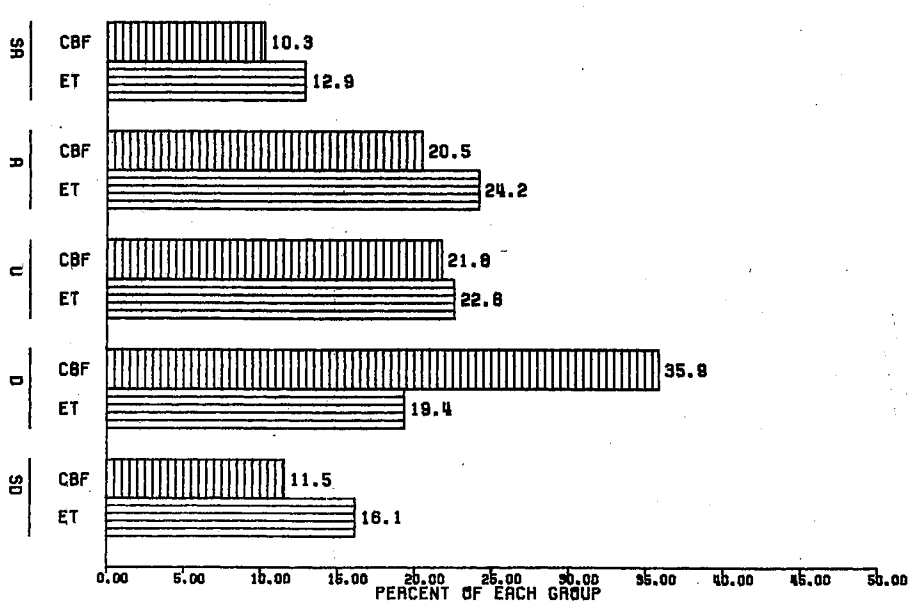

Figure 58. A General Education Biology Course Should Have No One Text

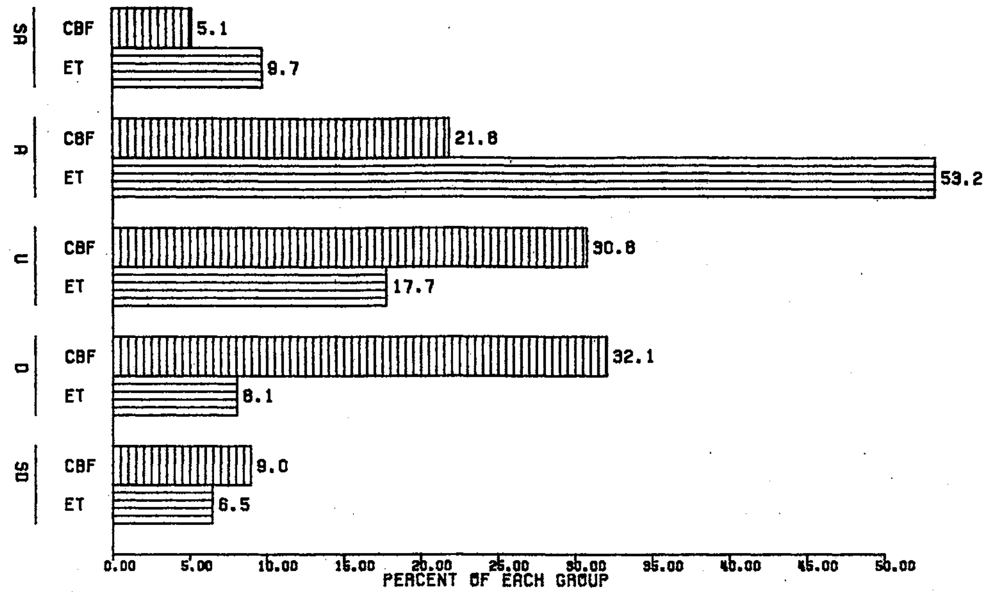

Figure 59. A General Education Biology Course Should Employ the Student's Help in Defining the Behavioral Objectives for the Laboratory

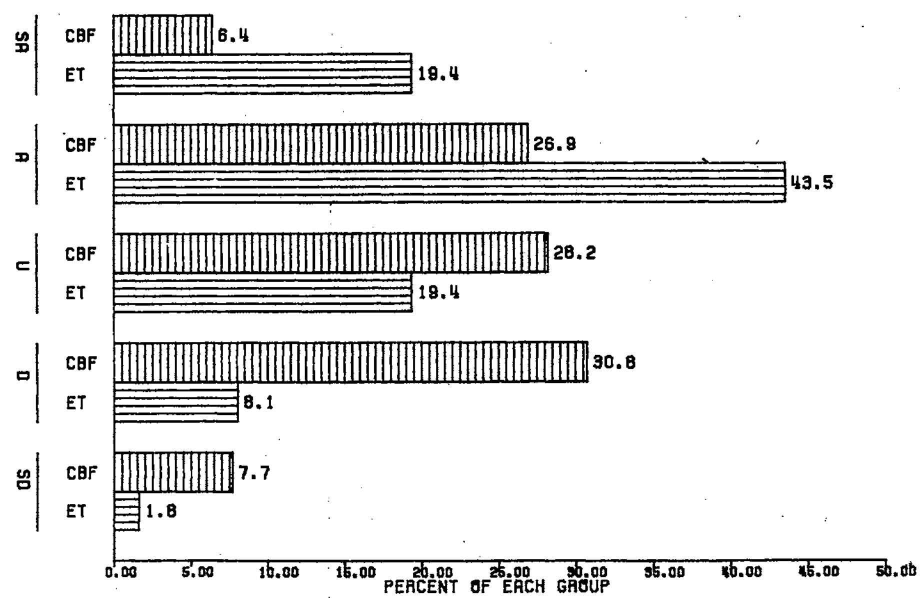

Figure 60. A General Education Biology Course Should Have a Flexible Laboratory Period With Various Groups Working on a Common Problem

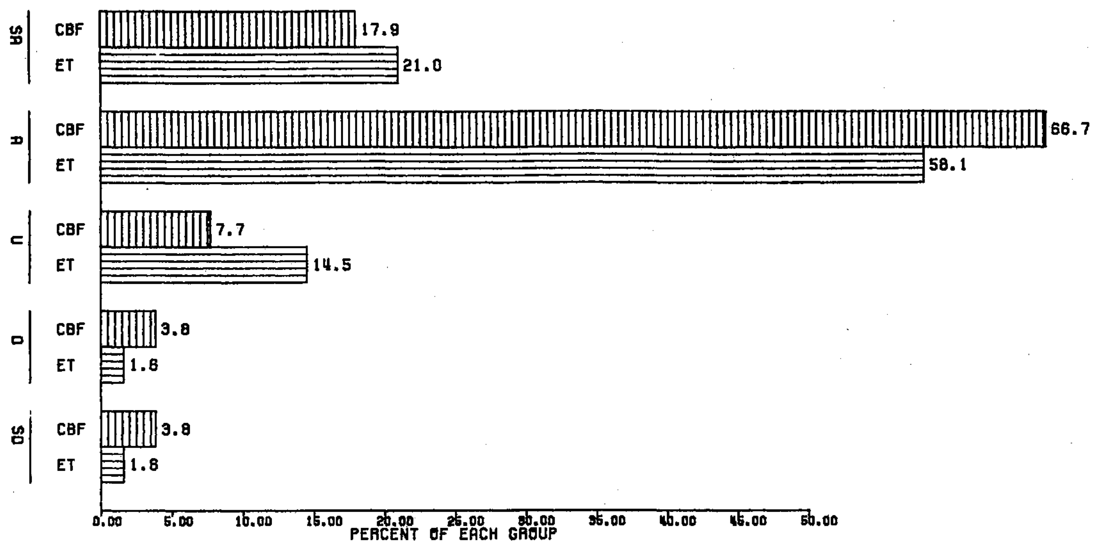

Figure 61. A General Education Biology Course Should Have Available a Departmental Tutor

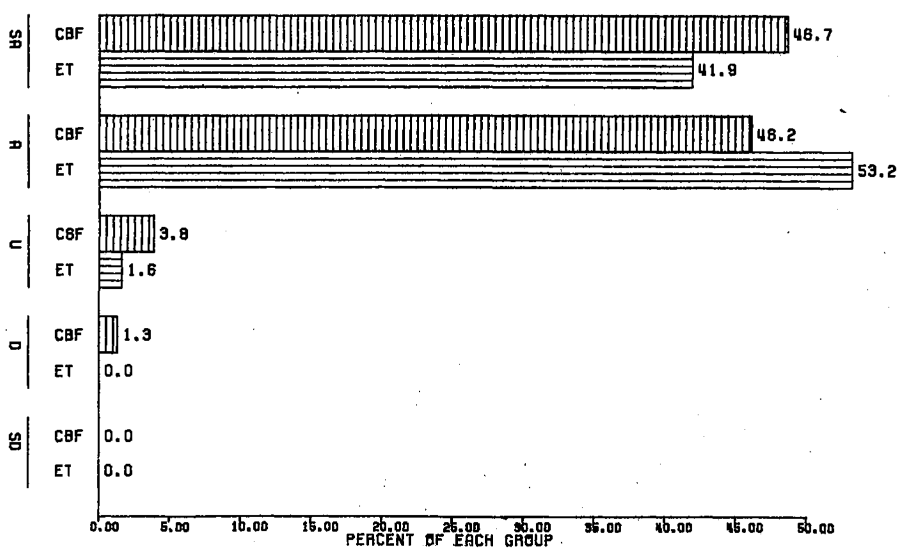

Figure 62. A General Education Biology Course Should Increase the Student's Powers of Observation in the Living World

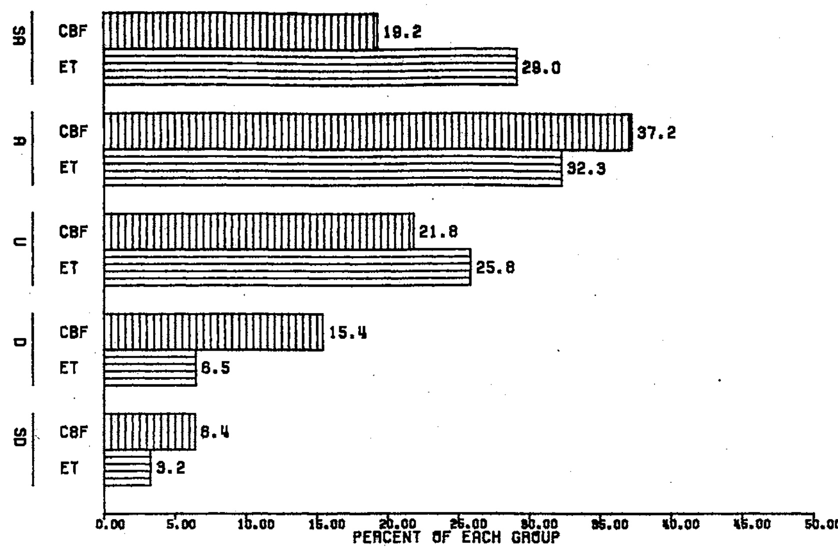

Figure 65. A General Education Biology Course Should Have Certain Standards of Achievement Established for the Course Prior to Testing

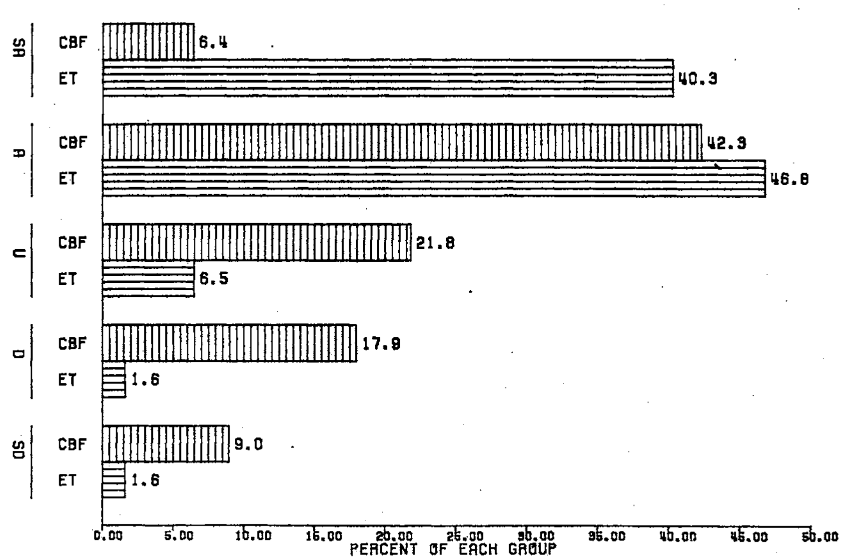

Figure 66. A General Education Biology Course Should Give Students the Option of Working On Individual Projects in Lieu of Other Course Requirements

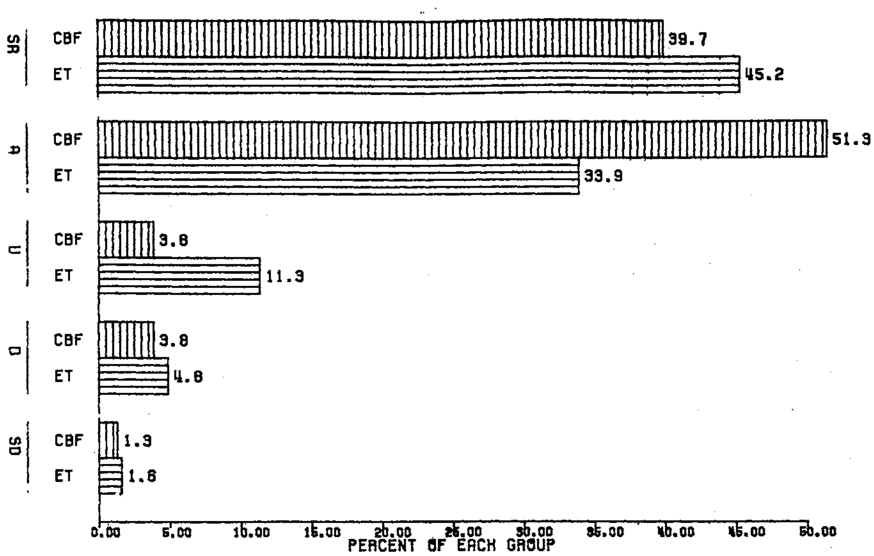

Figure 67. A General Education Biology Course Should Increase the Effectiveness of a Test By Rapidly Grading and Returning It

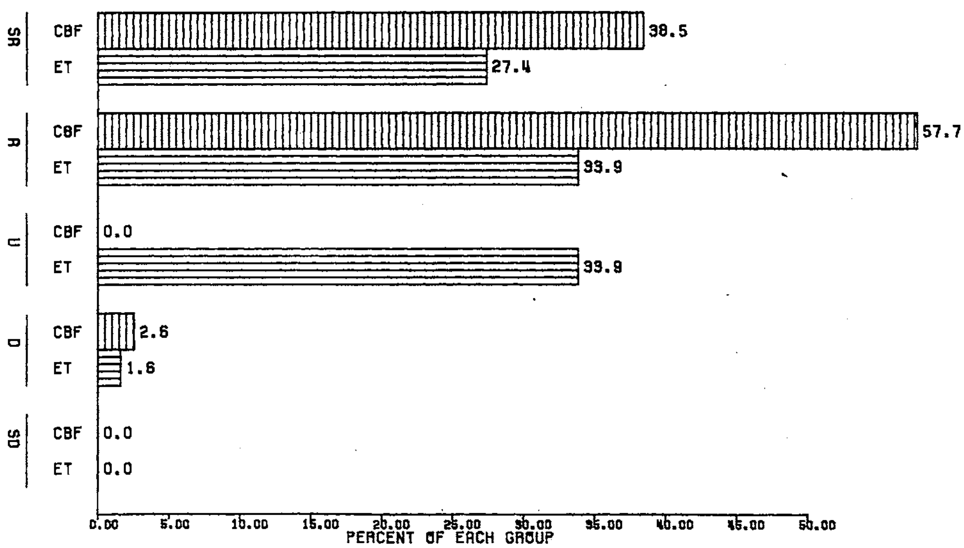

Figure 68. A General Education Biology Course Should Develop Scientific Attitudes Which Emerge From the Treatment of Biology as a Dynamic State

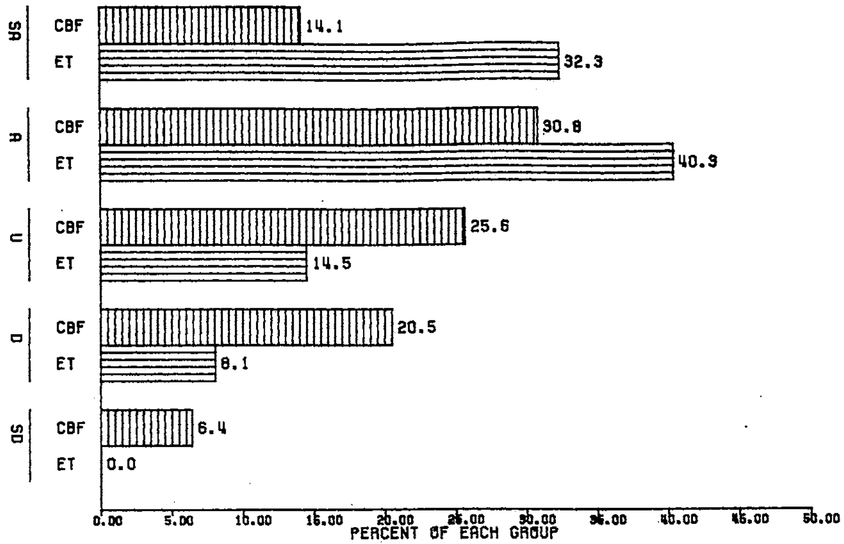

Figure 69. A General Education Biology Course Should Have Laboratory Experiments Which Allow a Student to Proceed at His Own Rate

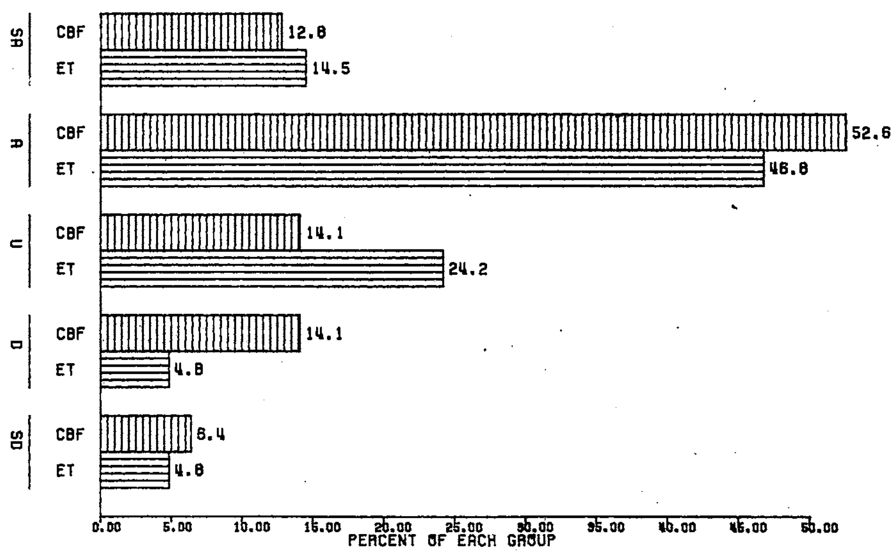

Figure 70. A General Education Biology Course Should Use the Text Chosen for the Course as a Guide for the Development of Curricular Content

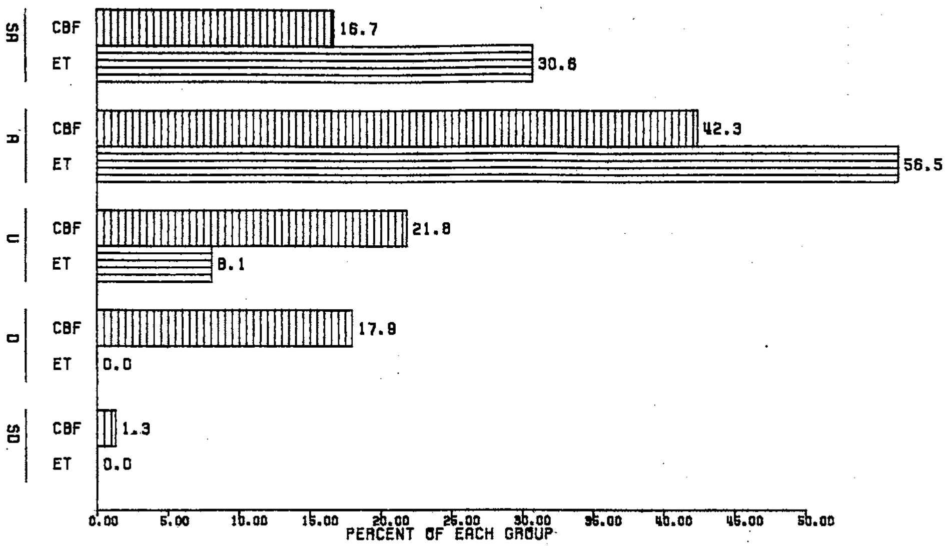

Figure 71. A General Education Biology Course Should Provide Training in the Basic Skills of Laboratory Techniques

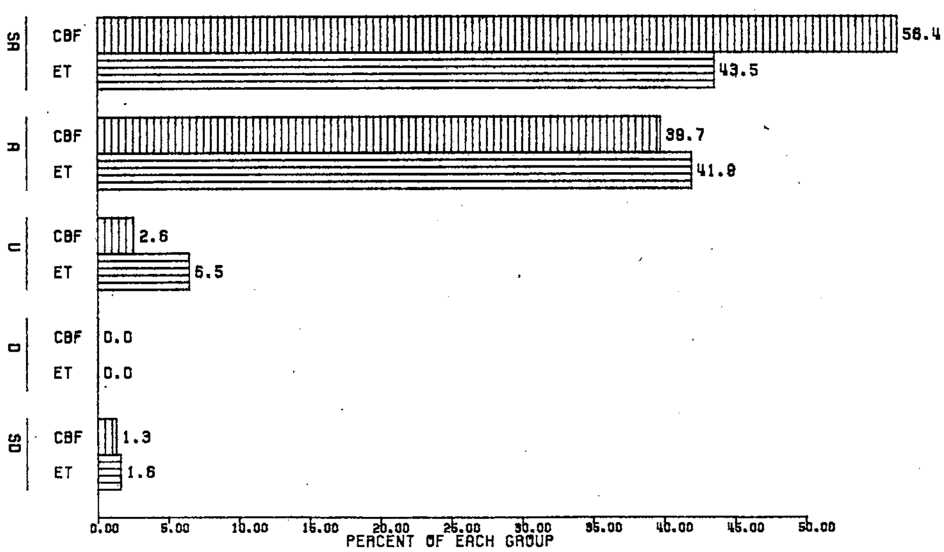

Figure 72. A General Education Biology Course Should Prepare Students for Intelligent Functioning in a Contemporary World

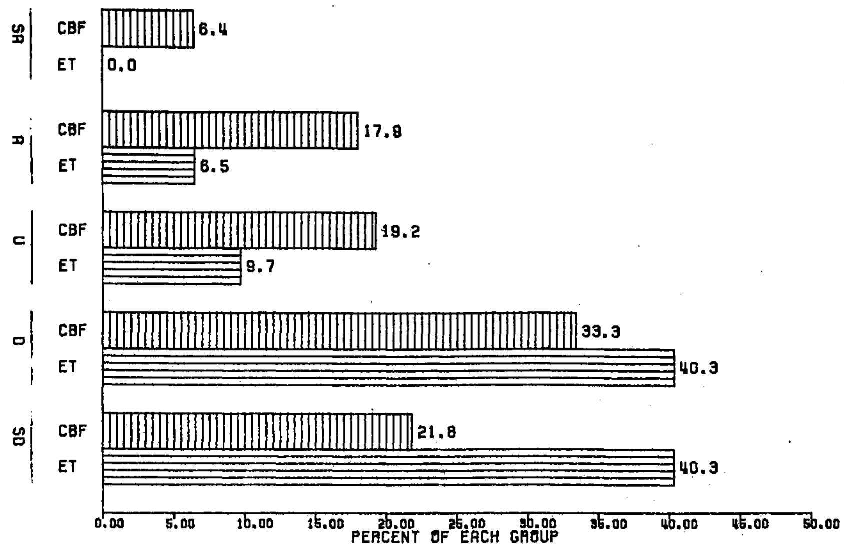

Figure 73. A General Education Biology Course Should Be Taught By the Lecture Method Primarily

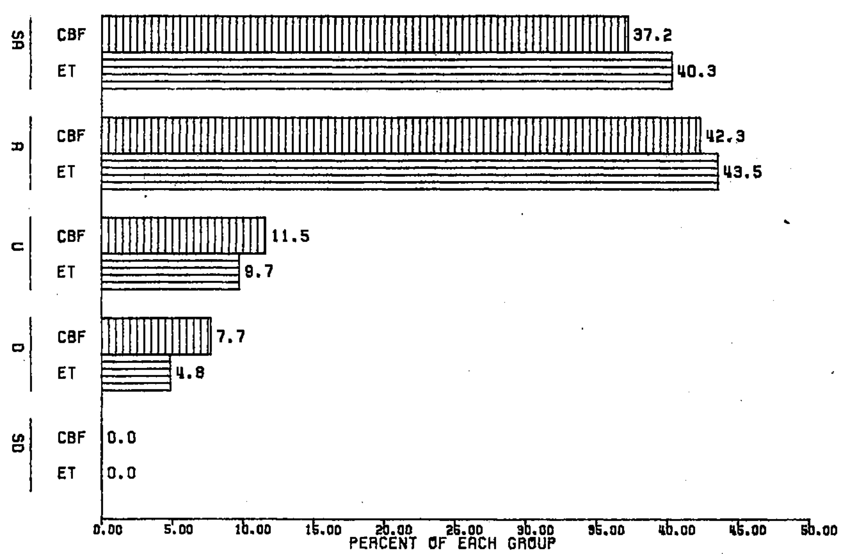

Figure 74. A General Education Biology Course Should Be Taught Using a Combination of Lecture, Inquiry and Individual Study

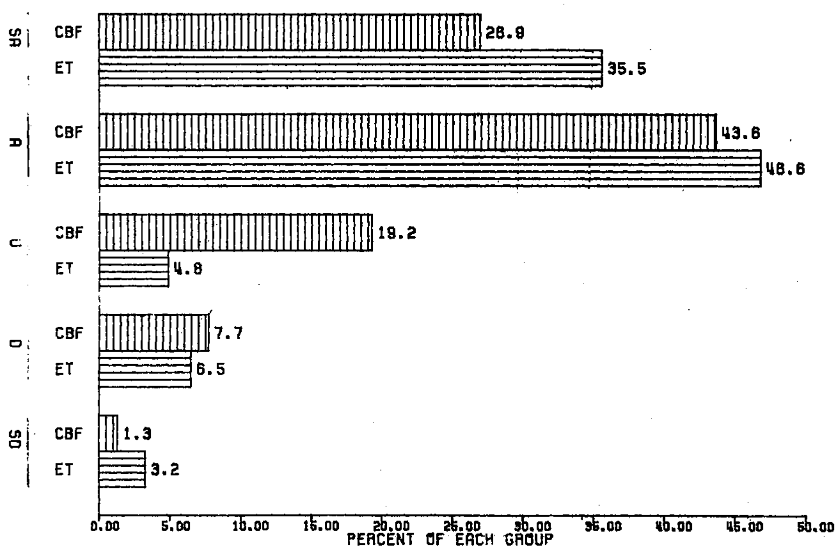

Figure 75. A General Education Biology Course Should Adjust the Method of Instruction to the Type of Students Found in the Classroom at Any One Time

APPENDIX D

DEVELOPMENT OF A BIOLOGY COURSE

A MODEL BIOLOGY COURSE

The results of this study indicate the form of curriculum development should be one with concern for the individual student as well as the discipline. This form is similar to one of four proposed by Dressel (22). Dressel states that if concern for individual students is an important part of a program development then objectives should emphasize the growth and development of the individual. Affective goals are as important as cognitive goals. The discipline represents a flexible but useful organization of knowledge. The development of a course which uses this scheme and follows the attitudes and opinions set forth by this study could be outlined in the following way:

I. Statement of the general biology course objectives.

II. Statement of behavioral objectives both for the classroom and the laboratory.

III. Select or devise laboratory experiments designed to increase the student's skill in scientific processes (observation, measurement, formulating hypothesis, etc.). The laboratory should also provide the kind of environment which stimulates student curiosity and encourages scientific investigation.

IV. Coordinate the laboratory with classroom lectures.

V. Develop audio-totorial laboratory lessons and a module unit for biological areas in which only some of the students are unprepared. (example: chemistry, basic measurement).

VI. Set aside an area near the laboratory which contains reference texts, 8 mm slide projectors and tables for student conferences and study.

VII. Ecology is the central theme. The lecture and laboratory is developed around the following units:

A. Activities of Life

1. Life processes common to all living organisms.
2. The four basic organic compounds found in living components.
3. Homeostasis.
4. Control by enzymes.
5. Cell physiology.
6. The functions of unicellular organisms.
7. Microorganisms.
8. Photosynthesis.
9. Respiration.
10. Plant and Animal Physiology.

B. The Past, the Present and the Future.

1. Reproduction.
2. Development.
3. Heredity.
4. Genes.
5. Genetic Code.
6. DNA and RNA.
7. Evolution.

C. Plant and Animal Ecology.

1. Classification.
2. Kinds of organisms.
3. Order is a constant theme.
4. Living World is made of ecosystems:
   a. populations
   b. communities
   c. biomes
5. Flow of energy.
6. Cycling of nutrients.
7. Population growth.

D. What is Man's Place in the World?

1. Earth has finite space.
2. Control of diseases.
3. Control of pests.
4. Man as a strong ecological force.
5. Man's social interactions.

VIII. The course should be taught using the inquiry, lecture, and and individual study approach. The inquiry method should be strongly emphasized in the laboratory. Inquiry may be used in discussion groups which devise problems and techniques to secure answers. Group study problems could be utilized to engage the students in active investigation providing an opportunity to approach the study of science in ways that have meaning for them.

Students may present current problems to the class for clarification, further investigation, and critical analysis. This activity could be used to develop desired scientific attitudes.

IX. Some lectures should be prepared but these should be developed around basic principles and those areas requiring special help for better understanding.

VITA

Dorothy Ann Frosch

Candidate for the Degree of

Doctor of Education

Thesis: AN INVESTIGATION OF THE COLLEGE GENERAL BIOLOGY CURRICULUM AS AN INTEGRATED PART OF THE PRESERVICE TRAINING OF ELEMENTARY TEACHERS

Major Field: Higher Education

Biographical:

Personal Data: Born in Guthrie, Oklahoma, June 10, 1926, the daughter of Mr. and Mrs. Newton P. Kellogg.

Education: Graduated from Guthrie High School, Guthrie, Oklahoma, in May, 1944; received Bachelor of Science degree in Education from Central State University in 1958; received Master of Teaching from Central State University in 1964; completed requirements for the Doctor of Education degree at Oklahoma State University in May, 1973.

Professional Experience: Science teacher Classen High, Oklahoma City, Oklahoma, 1958-65; served as chairman of Classen High School Science Department, 1964-65; biology and physics teacher Guthrie, Oklahoma, 1965-66; instructor of Science Central State University, Edmond, Oklahoma, 1966-69; assistant professor of biology/physics Central State University; Edmond, Oklahoma, 1965-72.