A SYNTHESIS AND EVALUATION OF OBJECTIVES FOR BIOLOGICAL SCIENCE IN THE BASIC COLLEGE OF MICHIGAN STATE COLLEGE

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BY

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A THESIS

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CHAPTER I

THE BACKGROUND OF THE PROBLEM

INTRODUCTION

With the development and subsequent growth of the program of general education in American colleges there have been changes in the objectives of many elementary courses. These changes have been motivated in part, at least, by a realization that an education should be related to the needs of the students. Whereas the traditional introductory course was primarily an introduction to a specialized field, general education is defined in the report of the Harvard Committee as that part of a student's whole education which looks first of all to his life as a responsible human being and citizen.[1]

Many social and economic factors have increased the enrollment in American colleges during the last fifty years. In 1940 colleges and universities had an enrollment of over 1,500,000 students, more than ten times as many as in 1890. As a result "educational institutions are not only being asked to educate increasing numbers of young people, but they are also being asked to educate students who in the mass are basically different from the students of an earlier day in previous education,

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[1] Harvard University, General Education in a Free Society. Cambridge: Harvard University Press. 1945. p. 51.

social background, and vocational objectives."[2] Many students who attend college have no specific educational or vocational objective, hence they do not need or desire highly specialized instruction. Those who do plan to enter vocations requiring training should also acquire a broad education unrelated to their vocation because they are also to be confronted with many problems outside their field. "The program of the upper high school and lower college years must therefore provide the general knowledge, skills, and attitudes required by this and succeeding generations."[3] These statements of the aims of general education are consistent with the reports of other committees who have studied the problem of general education.[4,5,6] Although varying concepts of general education have been expressed by different educators, "fundamentally there is a common concern that underlies all efforts to stress general education in the upper secondary and higher levels regardless of the different emphasis. It is a concern that grows out of (1) a dissatisfaction with higher education as

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[2] American Council on Education, Executive Committee of the Cooperative Study in General Education, Cooperation in General Education. Washington: American Council on Education. 1947. p. 12.

[3] Ibid., p. 13.

[4] William S. Gray, editor, Recent Trends in American College Education. Chicago: University of Chicago Press, 1931. p. 11.

[5] Kenneth L. Heaton and G. Robert Koopman, A College Curriculum Board on Functional Needs of Students. Chicago: University of Chicago Press, 1936. p. 7.

[6] John B. Johnson, The Liberal College in Changing Society. New York: The Century Company. 1930. p. 36-43.

now organized, (2) a reaction against an overemphasis upon specialization in the colleges, (3) a new body of information regarding the nature of a college and the characteristics of the student body, (4) the current youth problem in society, and (5) a deepened desire to do something that will make education more effective than it has been in the past, largely, perhaps, in the hope that future generations will be able to solve better such social problems as those that baffle present-day society."[7]

A general education program was inaugurated at Michigan State College in 1945. The function of the Basic College as presented in a report of the committee appointed for the study of general education is "to provide students with a sound foundation on which to build an intelligent interest in personal, family, vocational, social, and civic problems, a better understanding of these problems, and a greater ability to cope with them ..... Students whose training may eventually become highly specialized need this foundation of general educational experience that each may have a greater appreciation of the relationship of his special field to the needs of society as a whole."[8]

Many science courses have been planned to carry out the basic objectives set up for general education. In addition specific objectives

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[7] Alvin C. Eurich, "A renewed emphasis upon general education," in General Education in the American College. Thirty-eighth Yearbook of the National Society for the Study of Education, Part II. p. 6-7. Bloomington, Illinois: Public School Publishing Company, 1939.

[8] "Report of Committee appointed 'For Study and Recommendations' Concerning Basic Education at Michigan State College." Unpublished report, Michigan State College, 1944.

for science courses have been formulated. These will be discussed in Chapter II. Although the objectives of the course in biological science at Michigan State College have been stated,[9] they have not all previously been expressed in terms of desired outcomes, nor has any previous attempt been made to determine the relative importance of these objectives.

The present study is an outgrowth of an interest in the relation of educational objectives to the construction of examinations. Tyler[10] in a discussion on the history of objective tests, states that in 1927 criticism was directed toward the existing standardized tests because they did not cover all of the outcomes desired in an educational program. He further says that the educational objectives at that time were so indefinite that measures could not be devised to test them. The fundamental task in the construction of achievement tests is to make certain that important objectives are measured.[11] Richardson[12] points out that the course objectives, as far as the student is concerned, are represented

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[9] Education Committee, "Objectives for Biological Science." Unpublished report, Department of Biological Science, Michigan State College, 1946.

[10] Ralph W. Tyler, "The specific techniques of investigation: examining and testing acquired knowledge, skill, and ability", in Scientific Movement in Education. Thirty-seventh Yearbook of the National Society for the Study of Education, Part II, p. 341-355. Bloomington, Illinois: Public School Publishing Company, 1938.

[11] Ralph W. Tyler, Construction of Achievement Tests. Columbus, Ohio: Ohio State University, 1934. p. 4.

[12] M. W. Richardson, "The improvement of examinations at the University of Chicago." In Gray, William S., editor, Tests and Measurements in Higher Education. Chicago: The University of Chicago Press. 1936. pp. 155-61.

in the examinations. Because the entire evaluation of a student's achievement in the courses offered by the Basic College at Michigan State College is the comprehensive examination, it was deemed desirable to conduct a study on the relative importance of the stated objectives of the course in biological science, so that a method for testing each subject-matter area in terms of all of the important objectives of the course could be devised. For the purpose of this thesis it was considered advisable to delimit the problem and to investigate only the major objectives of the course.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study (1) to determine the instructional aims of the staff of biological science at Michigan State College, (2) to secure ratings of these objectives by a) the staff of biological science at Michigan State College, b) a group of faculty members of Michigan State College who were not members of the Department of Biological Science, c) a group of senior students who had completed biological science in their freshman year, d) a group of students who had not previously taken biological science, and e) groups of students completing each term of the three terms of the course, and (3) to interpret these ratings in order to determine the relative importance of the objectives to a) the teaching staff and b) the students.

The rating sheet was presented to the staff of biological science and a group of other faculty members because it was believed that they were both directly concerned with the objectives of a course in biology

offered in the Basic College. The rating sheet was presented to the seniors because it was believed that their experiences after taking the course in biology might be reflected in their responses to the rating sheet. The student groups were included in the study because it was believed that the needs and interests of the students should be considered in the final evaluation of the objectives.

Importance of the study. The curriculum, and consequently examinations, of the traditional college course in science were largely factual in content. The expressed aims of a course, however, are seldom to present only factual information. It is, therefore, of major importance to define the objectives of a course in terms of desired outcomes, and to evaluate these objectives.

II. ORGANIZATION OF REMAINDER OF THE THESIS

In Chapter II is presented a review of the literature on objectives of science teaching, as reported by committees making recommendations for objectives for science teaching at the college level and at the secondary level. This discussion is followed by a review of the literature on studies made on the frequency of mention of objectives in courses of studies, texts, journals, and by teachers. Studies on ratings of various objectives of the teaching of science are reviewed in the last section of Chapter II.

Chapter III deals with the method of obtaining the objectives studied, the rating sheet which was presented to two faculty groups and

five student groups, a description of the seven groups studied, a classification of the objectives, and the methods by which the data were analyzed.

Chapter IV is devoted to a comparison of the ratings of the objectives by the seven groups studied. The objectives stressed in the literature are compared with the objectives which the members of the Department of Biological Science considered the most important.

In Chapter V the ratings of those persons taking the comprehensive examination early with those not taking the comprehensive examination early are compared. Sex differences and age differences in responses to the objectives are also presented in Chapter V.

A summary of the results is presented in Chapter VI. The summary is followed by conclusions and educational implications of the study.

CHAPTER II

REVIEW OF LITERATURE

Although there is a vast amount of literature on objectives for science teaching, only two types of reports will be presented here. A few of the most recent and significant committee reports will be reviewed briefly. The principal emphasis of the review of literature on science objectives will be on those reports dealing with science instruction at the secondary and junior college levels. A more detailed discussion of reports which include actual investigation of the problem of objectives in science education will be included.

Review of significant committee reports on objectives of science education. Evidence of the changing attitude toward the function of introductory science courses at the college level is provided by the report of the Harvard Committee.[1] It criticizes the present college instruction in science for its emphasis on special fields, directed toward training future scientists. These courses devote most of their time to the development of a technical vocabulary and technical skills, in which the general student is uninterested and from which he gains little appreciation of the basic concepts of the science, the nature of scientific enterprise, the history of the development of the subject or its relationship with other areas of interest and activity. The Harvard Committee believes that

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[1] Harvard University, op. cit., pp. 220-230.

general education in science is necessary for the specialist as well as the general student in order that he may view science as a whole. Therefore, the members of this committee recommend that elementary courses in science be introduced into the curriculum which should convey an integrative viewpoint and are understanding of the scientific method. These courses should also teach an understanding of the means by which science has progressed, the basic concepts of the science, and the nature of man and knowledge. Courses should be designed to meet the needs of the students.

The report of the Harvard Committee was not the first one to criticize the traditional introductory courses in sciences in the colleges, nor is it as detailed in regard to the objectives of science courses as several others; it is presented first in the consideration of the literature because it has had considerable influence on the thinking of many other committees who are critically examining the curricula of their universities and colleges.

One of the earlier committee studies on science in general education was presented by Coulter[2] in Gray's "Recent Trends in American College Education." He sets up three major objectives for a biology course to be taught at the University of Chicago, namely, to cultivate some facility in application of the scientific method, to endow the student with some practical biological information, and to awaken an interest in the machinery of the organic world and in the large concepts that have been useful

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[2] Gray, editor, op. cit., pp. 61-67.

in the development of biology.

Another study of interest is that of Potthoff[3] presented in "Building a Curriculum for General Education." The objectives set up for the biology course at the University of Minnesota were to impart information of man as an animal in the organized scheme of nature, to educate the students in matters of personal and community health and to impart knowledge of the scientific method and encourage its use in thinking.

It is interesting to note that all three of these reports on objectives of generalized courses designed for the college student emphasize the importance of developing competence in the use of the scientific method. The teaching of major concepts of biology is mentioned in two of them.

One of the outstanding investigations on objectives of biological science at the college level is presented by Greulack[4] in a committee report entitled "A College Looks at its Program." The first step in the formulation of these objectives was an examination of every available source of objectives for biology and other science courses. To this list were added other objectives related to the training of elementary teachers. This list of objectives was revised by combining several similar objectives, and was then revised four times on the basis of the criticism of the committee on experimentation at Muskingum College, the faculty of Muskingum College and Ralph W. Tyler, (then of Ohio State University)

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[3] Ivol Spafford, editor, Building a Curriculum for General Education. Minneapolis: The University of Minnesota Press, 1943. pp. 245-261.

[4] Muskingum College. A College Looks at its Program. Columbus: The Spahr and Glen Company. 1937. pp. 139-146.

who was research counselor at Muskingum College. The objectives as stated in 1937 are comprehensive, expressed in terms of desired outcomes, and include such important outcomes as the development of scientific methods of thinking, the understanding of functional biological information, and the acquisition of desirable scientific attitudes. This study is included here as evidence that in at least a few institutions objectives of college courses were carefully considered, that they were expressed in terms of desired outcomes of behavior, and that the course was designed for the general student and not for the specialist.

A few of the outstanding committee reports on the objectives of science teaching in the grades below the first year of college will be present to show that the aims of science courses in general education at the college level are consistent with the objectives at the secondary level. In 1932 the Thirty-first Yearbook of the National Society for the Study of Education[5] gave as major objectives of science teaching the development of an understanding of the major generalizations of science and the development of scientific attitudes.

The needs of adolescents in science as expressed in broad areas by the Progressive Education Association[6] are 1) personal living, 2) personal-social relationships, 3) social-civic relationships, 4) economic relationships and 5) ability to think reflectively. Although each of

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[5] Program for Teaching Science. Thirty-first Yearbook of the National Society for the Study of Education, Part I. p. 44. Bloomington, Illinois: Public School Publishing Company, 1932.

[6] Progressive Education Association. Science in General Education. New York: D. Appleton-Century Company. 1938. pp. 27-49.

these categories of needs is discussed in detail, especially with respect to functional subject matter, the objectives have not been expressed in terms of desired outcomes, and hence it is difficult to compare this report with others on objectives of science.

The most recent committee report to be considered here is that presented in the Forty-sixth Yearbook of the National Society for the Study of Education.[7] Certain criteria have been set up for the formulation of objectives by this committee. The recommendations are that the objectives should be practicable for the classroom teacher, psychologically sound, possible of attainment, universal in a democratic society, and should indicate the relationship of classroom activity to the desired changes in human behavior. On the basis of these criteria the committee has suggested eight categories of objectives, namely 1) functional information or facts, 2) functional concepts, 3) functional understanding of principles, 4) instrumental skills, 5) problem-solving skills, 6) attitudes 7) appreciations, and 8) interests.

In each of these findings of committees on science education there is emphasis on the desirability of functional understanding of the techniques of the scientific method. Each stresses the desirability of teaching the major generalizations rather than isolated facts. It is difficult to compare the report of the Progressive Education Association with the report in the Forty-sixth Yearbook because the former has outlined the

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[7] Science Education in American Schools. Forty-sixth Yearbook of the National Society for the Study of Education, Part I. pp. 19-40. Chicago: University of Chicago Press, 1947.

needs in the major areas of living and methods of implementing these needs, whereas the Yearbook committee has considered the major types of learning outcomes. As is pointed out in the committee report of the American Council on Education[8] there are two "dimensions" in terms of which educational objectives must be considered. These are; the broad areas of living within which the purposes, activities, and difficulties of students operate; and the types of activities, learnings, and outcomes which attend each of these areas. In order to facilitate the discovery of specific needs the committee on Cooperative Study in General Education suggests the construction of a chart with the fields of human experience listed in the lefthand column and the types of desired outcomes arranged across the top of the page. Intersections then suggest specific needs.

In comparing the conclusions which deal primarily with the objectives of science education in the secondary schools with those on objectives of science in general education at the college level it is of interest to note that all six reports have stressed the importance of teaching the scientific method, four have stressed the importance of teaching general concepts and three have emphasized the social importance of science.

Review of literature on studies of objectives of science. There have been numerous reports on subject-matter content objectives. Persing[9] made an investigation of the subject-matter objectives of biology listed

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[8] American Council on Education, op. cit., pp. 65-67.

[9] Ellis C. Persing, "Present objectives in biology." Science Education, 17: 24-34, February, 1933.

in sixteen publications, five curriculum studies, five courses of study and six text books. A more comprehensive study was made by Wray[10] who presented to teachers, engineers, students, laborers, house-wives, secretaries, etc. a questionnaire of 1550 items of chemical information to be checked for frequency of use and for pleasure in knowing the information. Although this type of study is of interest in a consideration of the literature on studies on objectives, it is not sufficiently related to the present study to warrant a detailed review of the literature on subject matter objectives.

There have, however, been a number of studies conducted on general objectives of science teaching which are pertinent. Two types of approaches to the problem of objectives have been used. An analysis of frequency of mention of objectives in text books, educational journals, committee reports, courses of study, and in questionnaires to science teachers constitutes one of these approaches. The other method of study is the presentation of a selected list of objectives for evaluation.

One of the first studies of the former type was an investigation made by Beauchamp[11] in 1932. He analyzed stated objectives in courses of study of 58 courses in general science, 45 courses in biology, 27 courses in physics and 30 courses in chemistry. Twenty-six states were represented in this investigation. Each course of study was examined to determine the objectives mentioned. An interesting observation is made

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[10] Robert P. Wray, "Organizing of secondary school chemistry according to utilitarian principles." Science Education, 19: 141-149, Dec., 1935.

[11] Wilber L. Beauchamp, Instruction in Science. U. S. Office of Education Bulletin, 1932, No. 17, Monograph No. 22. Washington: Government Printing Office. 1933. pp. 9-14.

in this report. "The objectives of the courses in general science .... were more general and would apply to any field of science, whereas the objectives of courses such as biology, physics, and chemistry were very specific."[12] Beauchamp explains this by the fact that the special science teacher is trained in the subject matter of the course and thus tends to express his objectives in terms of content rather than in terms of general outcomes. Beauchamp has classified the objectives in six categories namely; knowledge, exploration, abilities, attitudes, ideals, habits, and interests. A wide range of objectives is presented, 63 in all. The objectives are presented for the four sciences studied. Because the present investigation is dealing with objectives of biology, the objectives as presented for biology by Beauchamp will be discussed here. Of the 32 courses of study for biology, the following objectives were most frequently mentioned; to acquire knowledge which will produce a better understanding of our environment, to acquire knowledge which will lead to more healthful living, to appreciate nature, to acquire knowledge for worthy use of leisure time, to acquire knowledge of principles of biology. Only five courses of study gave as an objective, to develop ability to think scientifically. It is of interest to compare this latter number with the number of general science courses of study which mentioned ability to think scientifically, where the number was 44 out of 51. Of the scientific attitudes only one was mentioned in one course of study for biology; to be openminded. Beauchamp points out that little importance

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[12] Ibid., p. 10.

should be attached to the frequency of mention of the objectives in courses of study and that they should not be a criteria for determining what the objectives should be.

In the same year that Beauchamp's report was prepared for publication Hunter and Knapp[13] reported results of a questionnaire sent to science teachers of secondary schools. A section of the questionnaire asked that the major aims of science teaching for the junior high level and the senior high level be listed. Replies on objectives were received from 393 schools. This number included replies received from both the junior and senior high schools. The same questionnaire was also sent to each member of the National Association for Research in Science Teaching. A large per cent of these members replied. Hunter and Knapp state that "the replies from this group may be considered as representing what the experts in the field of science teaching think should be the real objectives of teaching science, while the replies of the teachers themselves should be representative of what objectives are actually functioning in the secondary school."[14]

Some individuals mentioned only one objective while others mentioned as many as ten; the majority specified a number somewhere between these two extremes. The major objectives mentioned by the teachers were; to help the pupil understand his environment, to prepare him for further

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[13] George W. Hunter and Roy Knapp. "Science Objectives at the Junior-and Senior-High School Level." Science Education, 16:407-416, October, 1932.

[14] Ibid., p. 407.

work in science or for college preparation, to give information, to master the scientific method, and to arouse interest in science. One of the most interesting phases of this investigation was the comparison of the objectives of senior high school teachers with the objectives indicated by members of the National Association for Research in Science Teaching. The propaedeutic functions of science and the acquisition of information were those most frequently mentioned by the senior high school teachers, whereas the research group mentioned these objectives relatively infrequently. The objective mentioned most frequently by the latter group was mastery of the scientific method, while this objective was mentioned third most frequently by the teachers. The objectives in second and third place in frequency of mention by the research group were respectively; to develop a scientific attitude toward all problems and to understand the environment.

Winokur,[15] in 1936, presented a report on the results of a questionnaire received from 68 collegiate institutions teaching generalized science courses. Some of these were courses in biology, some were courses in physical science, and some were both. The objectives of the courses were requested and the frequency of mention of each type of objective was tabulated. Fifty-four of the 68 gave as an objective to teach knowledge of the subject matter of the course. Only 22 of the 68 gave the teaching of the understanding of the major generalizations of science as a major objective. An understanding of the scientific method was mentioned by only twelve, and twelve others thought that an appreciation of the scientific attitude was

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[15] Morris Winokur, "A Survey of Generalized Science Courses in Institutions of Higher Education." Science Education, 20:132-140. October, 1936.

an important objective. It would appear that in 1936 even in those college courses which were supposedly for the general student the major emphasis was on the facts of the science.

A more comprehensive survey of general education courses in science being offered in the college was reported by Hard and Jean[16] in 1938. Of the 209 questionnaires sent out 177 or 84.7 per cent were returned. The recipients of the questionnaires were asked to check the four following objectives:

1. The acquirement of pure science facts.
2. The acquirement of generalized understandings.
3. The acquirement of skill in valid and reliable thinking.
4. The acquirement of socially acceptable scientific attitudes.

The respondents were asked to check either that the principle objective of the course was the acquirement of facts or principles. That is, they were asked to choose between objective one and objective two. Although 93.1 per cent checked the second, 33.5 per cent checked the first; in other words, many felt that both were essential. The ability to use the scientific method (objective # 3) was believed to be important by 90.2 per cent of the group, while 76.3 per cent believed that scientific attitudes should be acquired during the course of instruction. There are several possible explanations for the discrepancy in the findings of Hard and Jean and those of Winokur. The group which was studied by Hard and Jean may have been more representative than that studied by Winokur. In the opinion of the author the most logical explanation is that Winokur

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[16] H. O. Hard and F. C. Jean, "Natural Science Survey Courses in Colleges." Science Education, 22:294-299, November, 1938.

asked for an expression of objectives in the respondents own words, whereas Hard and Jean presented alternate objectives. It is probable that many persons would include the major generalizations of science as teaching of the facts of science, and feel that they had covered both in a single statement.

A very comprehensive study of stated objectives was reported by Noll[17] in 1939. All of the aims of science teaching that could be found in text books of science, courses of studies, committee reports, articles, and periodicals were listed. A total of 130 sources were included in the analysis. The aims were grouped for different subject areas (for example, biology, chemistry, etc.) and by educational levels. The frequency and proportion of sources mentioning each objective were obtained. The objectives were classified as to knowledges, abilities, habits, appreciations, attitudes, and interests.

The principle emphasis in these objectives at all levels was found to be on knowledge; at the senior high level 51.5 per cent of the objectives listed in the various sources were knowledge aims. There was an increase in emphasis on knowledge of principles through the grades and a decrease in emphasis in knowledge of environment. There was also a decrease through the grades in frequency of mention of the aims related to habits and appreciations. Attitudes were not mentioned at all in 15.4 per cent of the sources examined. Noll believes that teachers are thinking in terms of subject matter rather than in terms of the needs of

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[17] Victor H. Noll, The Teaching of Science in Elementary and Secondary Schools. New York: Longmans, Green and Company, 1938. pp. 5-21.

their pupils. "Until science teachers learn to think of the purposes of their work in terms of changes to be brought about in the thinking and behavior of the pupils rather than in terms of facts . . . . . science teaching will be taught as a body of organized knowledge."[18] Noll continues his criticism of the stated objectives of science with the comment that if those who occupy positions of leadership in the teaching of science do not think in terms of function rather than subject matter, there is little hope that the teachers will ever deviate from the traditional pattern of presenting facts for memorization. In this reference it is pointed out that knowledge of facts should not be an aim of the teaching of science. This body of knowledge, he believes, is a prerequisite to the attainment of the true aims of science, such as the understanding of nature and its organization in order that man may understand his place in it, appreciate the complexity and orderliness of it, etc. A change in emphasis of this sort should have a wholesome influence on science instruction at all levels of instruction.

In summarizing the studies which have been made on the frequency of mention of the objectives of science, it may be pointed out that the teaching of knowledges is the objective most frequently mentioned in all of the reports, but that an understanding of the scientific method is not neglected as a stated objective.

A few studies have been reported in which goals were listed and were submitted to various groups for rating. One of the first of these

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[18] Ibid., p. 11.

was reported in 1930 by Berner.[19] A study was made by a group of students at the University of Wisconsin to discover, classify, clarify, and define objectives of science teaching and to determine which objectives should receive major emphasis in the choice of subject matter. Twenty-five students of a graduate course in education collected lists of objectives from textbooks, courses of study, periodicals, etc. These were classified according to knowledges, abilities, habits, appreciations, attitudes, purposes (drives), ideals, and interests. In all, 57 distinct objectives were stated. All of the students in the class were asked to rank these objectives by placing them in five groups. Each objective received as its rating the sum of the ratings given by the class. The objectives ranked highest by the class were: the habit of scientific thinking, a scientific attitude, and knowledge which will give insight into the nature and organization of the environment, making it an organized whole instead of a lot of disjointed parts.[20] Four of the first five ranks were given to non-knowledge objectives. Although this group was small, and hence cannot be considered representative, the report is of considerable interest because a technique was presented here which has been modified and used by other investigators.

In 1938 the committee on secondary school science of the National Association for Research in Science Teaching[21] sent a questionnaire on

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[19] L. M. Berner and Others, "Objectives of Science Teaching." School Science and Mathematics, 31:550-559, May, 1931.

[20] Ibid., p. 555.

[21] "Report of Committee on Secondary School Science of the National Association for Research in Science Education," Science Education, 22:223-233, October, 1938.

science teaching practices to 100 selected specialists in the field of secondary school science teaching; 71 responses were received. This group included all of the members of the National Association of Research in Science Teaching plus a few curriculum specialists. Therefore, this report represents what the specialists in the field of science teaching believed the objectives of science instructions should be and not what the majority of teachers are using as their objectives for teaching. The questionnaire was made up of nine main divisions one of which was objectives of secondary school science. Rating of the items was made on a five point scale. The scale ranged from one, implying great importance, to five, denoting unimportance. Complete disagreement with the issue was checked in a column of the questionnaire marked X and a Y column was used for items which were not understood by the respondent.

The items which received the highest ratings were those related to the scientific attitude; for example, an objective attitude toward facts, an understanding of cause and effect relationships, freedom from superstition, and a willingness to suspend judgment. (The ratings of these specialists will be compared to the ratings obtained in the present study and will be presented in more detail in Chapter IV). The ability to think scientifically was the major objective given the second highest rating, while mastery of fundamental knowledges was ranked third in importance. The lowest ranking was given to the objective of training students for specific science vocations.

Hunter and Spore[22] in 1943, report the results of a rating sheet

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[22] George W. Hunter and Leroy Spore, "The Objectives of Science in the Secondary Schools of the United States." School Science and Mathematics, 43:633-647, October, 1943.

of thirty objectives formulated principally from the list derived from a questionnaire sent to teachers, reported by Hunter and Knapp[23] in 1932 and referred to earlier in this paper. The respondents were asked to rate these objectives as they were being taught, not as teachers believed that they should be taught. The objectives were rated on a four point scale. In addition a column was provided for a response indicating complete disagreement with the statement. The ratings of teachers from 655 schools were tabulated and graphs were made indicating the emphasis placed on each of the thirty objectives. The data were analyzed separately for the junior and senior high school levels. The objective which received the highest rating at both levels was one of understanding the environment. An understanding of personal health needs, appreciation of the environment, and knowledge of the environment were objectives which ranked high at both levels of instruction. Those objectives which had to do with attitudes and techniques of the scientific method collectively received ratings which would indicate that these objectives are not being neglected in present day teaching of science. It is heartening to note that "these objectives are rated as much more important today than they were ten years ago according to statements of teachers . . . . It is interesting, however, to note that in 1930 the membership of the National Association of Research in Science Teaching largely supervisors, training teachers, and university professors rated these objectives much higher than did the teachers, thus showing that

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[23] Hunter and Knapp, op. cit., pp. 407-409.

leadership in educational matters is slow in acceptance by the rank and file of the teaching profession."[24] One of the most striking differences between the two studies of Hunter is the place of preparation for college as an objective. In the earlier report, propaedeutic functions stood high on the list of teacher's objectives, whereas in the later report, these were the objectives which received the lowest ratings by teachers.

In summarizing the literature on objectives of science teaching, certain important trends can be noted.

1. There has been progress toward objectives which are functional and which are based on the needs of the student.

2. There is uniform agreement among educators that objectives should bring about desired changes in behavior of the students.

3. The committees which have studied objectives and reported on them, and other leaders in the field of science education emphasize the importance of such objectives as the ability to think independently, and the development of scientific attitudes.

4. Earlier studies of objectives show that the principle emphasis of the teacher was on subject matter and teaching of facts; however, later studies show that objectives other than informational ones are now being emphasized in the secondary school.

5. The objectives stated by committees on science teaching at the college level are consistent with the objectives formulated for the teaching of science in the secondary school.

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[24] Hunter and Spore, op. cit., p. 639.

CHAPTER III

METHODS OF PROCEDURE

As a preliminary step in this study the members of the Department of Biological Science of Michigan State College were asked to submit lists of objectives which they believed were important in the teaching of a course in biology in a general education program. The objectives turned in were studied and those which were not expressed in terms of desired outcomes were formulated in such terms. For example, such a statement as the following: "teach the student attitudes which he should use in solving a problem (objectiveness, unprejudiceness, etc.)" was considered as several objectives, and was expressed in terms of the change desired in the student rather than in terms of what was to be taught. One objective based on the statement was "to develop freedom from prejudice."

There was considerable overlapping of the objectives as stated by the members of the staff of biological science. In such cases the objective which was the most concisely and clearly stated was selected. In a few instances two or three very broad objectives were submitted, such as "to teach the scientific method," "to teach functional knowledge." These objectives were used as major categories and relevant objectives were grouped according to these broad areas.

The following rating sheet was derived from the list of objectives submitted:

The purpose of this study is to find out what you believe the aims (objectives) of this course in basic biology should be. The objectives listed below have been compiled from a list presented by the members of the staff of the department of biological science. We should like to have you check them in order to determine how important each of these objectives is to you. Mark those which you believe to be the most important with a 1. Those which are the least important to you mark with a 5. Mark the rest 2, 3, or 4 depending upon whether you consider them to be quite important, of average importance, or relatively unimportant. If you do not know what a statement means mark it with an X.

Key

1. Those which are the most important.
2. Those which are quite important.
3. Those which are of average importance.
4. Those which are relatively unimportant.
5. Those which are of the least importance.
X. Those which you do not understand.

PLEASE READ THE ENTIRE LIST OF OBJECTIVES BEFORE RATING THEM

Rating

( ) 1. To acquire a vocabulary of useful biological terms.

( ) 2. To acquire knowledge of some of the basic laws of biology.

( ) 3. To become familiar with biological facts which will lead to more healthful living.

( ) 4. To become familiar with biological facts which will contribute toward social good.

( ) 5. To understand the relation of man to his environment.

( ) 6. To understand the relation of structures to their functions.

( ) 7. To learn to apply the basic laws of biology; for example, the law which states that only green plants have the ability to manufacture food emphasizes the dependence of all animals including man on plant life.

( ) 8. To acquire the ability to detect and state a problem.

( ) 9. To learn to formulate hypotheses (possible solutions to a problem).

( ) 10. To acquire the ability to plan experiments to test hypotheses.

( ) 11. To learn to make accurate observations.

( ) 12. To learn to organize the facts obtained from observations and experiments.

( ) 13. To learn to read and construct graphs and tables.

( ) 14. To learn to interpret facts, that is, to draw conclusions.

( ) 15. To learn to use scientific apparatus, such as the microscope.

( ) 16. To become able to recognize true cause and effect relationships, that is, to learn to avoid making unscientific rationalization. For example, to recognize that most diseases are the result of infection, not a punishment for sin.

( ) 17. To learn to distinguish a fact from a theory.

( ) 18. To learn to transfer the method of scientific thinking to one's own problems and to social problems.

( ) 19. To acquire the ability to recognize important biological problems which are still unsolved, such as the cause of cancer, etc.

( ) 20. To develop an attitude of openmindedness, that is, a willingness to accept the results of objective observations.

( ) 21. To develop freedom from superstition.

( ) 22. To develop a willingness to suspend judgment until sufficient facts are gathered.

( ) 23. To develop freedom from prejudice.

( ) 24. To develop intellectual curiosity.

( ) 25. To become acquainted with the nature and extent of the professional fields of biology, such as, forestry, entomology, zoology, etc.

( ) 26. To develop an appreciation of the esthetic values of nature; that is, to appreciate the artistic elements of biology.

( ) 27. To acquire a background for avocational reading.

( ) 28. To acquire other avocational interests such as nature study, etc.

( ) 29. To acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life. For example, an understanding of evolution, and of interrelationships of living things may affect one's philosophy of life.

( ) 30. To become familiar with the sources of biological literature.

( ) 31. To appreciate the economic values of biology.

( ) 32. To develop an appreciation of the efforts, hard work, and accuracy that are necessary in any scientific investigation.

The rating sheet was presented to the twenty-six members of the Department of Biological Science of Michigan State College in May, 1947. The rating sheet was sent with a letter[1] explaining the purpose of the study to 100 of the teaching faculty, selected at random from the Faculty Directory of Michigan State College in January, 1948. Of this group 55 returned the questionnaire. Two of the returned questionnaires, however, were very incompletely rated and were, therefore, omitted from the tabulation of these returns. The analysis of this group was made on the basis of 53 replies, 53 per cent of those sent out.

The rating sheet was presented to five groups of students. The course in biological science at Michigan State College was given for the first time during the academic year 1944-45. In January, 1948, the rating sheet was sent with a letter[2] explaining the purpose of the study to 140 students, most of them seniors, who had taken the course the first year it was offered. Replies were received from 73 of these students, or from 52.1 per cent. Of the replies received twelve, or 16.4 per cent, were from men and 61, or 83.6 per cent, were from women students. This high percentage of women in the class the first year was due to the war.

It was deemed advisable to obtain ratings from a group of students

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[1] See appendix

[2] Ibid.

who had not had any biology in college, so the rating sheet was given in September, 1947, to 298 students entering the first term of the course. The rating sheet was presented the first day of class. Of this group, 98, or 32.9 per cent, were women students, while 200, or 67.1 per cent, were men students. The group ranged in age from sixteen to thirty years of age.

At Michigan State College most of the Basic College courses are offered every quarter, so during all quarters there are classes of each term of the three-term course. Credit and honor points in the courses in the Basic College are entirely dependent upon the grade made on the comprehensive examination, which is normally taken after the student has completed three terms of the course. The comprehensive examination is given at the close of each quarter and covers the three terms of work in the course. The students who show profiency in biology can receive a full year's credit in the course by taking the comprehensive examination before completing the three term's work. This privilege is granted only to the superior students.

Because the population of each term of the biology course (that is, Basic 121, 122, 123) is somewhat different, due to the fact that some of the best students take the comprehensive examination early, and some of the poorest students fail or drop out of school, it was deemed advisable to obtain ratings from students in all three terms of the course. The rating sheet was presented at the close of spring term in May, 1947, to three groups of students enrolled in biological science. Three hundred and twenty-five of these students had completed the first term of the

course, 312 had completed the second term of the course, and 319 had completed the third term. Of 151 of the 325 in the first term group 132, or 87.5 per cent, were men and 19, or 12.5 per cent, were women. The group ranged in age from 17 to 37 years of age. Of the second term group 277, or 88.8 per cent, were men and 35, or 11.2 per cent, were women. This group ranged in age from 17 to 34 years of age. Age and sex data were not obtained for the third term group.

The results of the ratings were tabulated and the percentages of each rating for each of the seven groups were calculated. The average rating for each objective for each of the seven groups was also calculated and from these averages the objectives were ranked according to their importance to each group. These data are presented in Chapter IV.

Students in the first and second term of the course were asked to designate on the rating sheet whether or not they were taking the comprehensive examination at the close of that term. Of the first term group 18.1 per cent planned to take the comprehensive examination at the close of that term. Of the second term group 31.1 per cent of the students planned to take the comprehensive at the end of that term. These percentages are somewhat higher than normal because veterans were allowed to take the comprehensive examination with somewhat lower marks than the regular students. Ratings of objectives by students taking the comprehensive examination early, that is, the superior students, are compared with the results of the ratings of the students who did not take the comprehensive early. The responses were interpreted in terms of percentages of responses obtained. These data are presented in Chapter V.

In order to study sex and age differences certain groups; namely, the entering group, part of the first term group, the second term group, and the seniors were studied regarding these characteristics. These data are presented in Chapter V.

In order to treat the data obtained in this study in terms of types of objectives which were of major importance to the various groups studied it was deemed advisable to classify these objectives. The classification selected as most satisfactory for this purpose was a modification of the one presented in the Forty-sixth Yearbook.[3] The first and second categories mentioned in the classification of objectives in this Yearbook are; functional information of facts, and functional concepts. Because there is some overlapping in these categories and because knowledge of both facts and concepts is implied in some of the objectives as they were stated in the rating sheet presented to the various groups, the author has grouped these categories together and has called them knowledge objectives. The third objective mentioned in the Yearbook is a functional understanding of principles. In the present report all objectives which are stated as understanding objectives will be placed in this category. It is admittedly difficult to separate knowledge objectives from understandings, because the teacher usually hopes that knowledge will become a part of the apperceptive mass which will increase understanding of concepts and principles. The separation of these two types of objectives is probably superficial, but since some of the objectives were stated in terms of knowledge and some in terms of understandings, they will be classified under these categories.

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[3] Science Education in American Schools, op cit., pp. 28-29.

The fourth category of objectives mentioned in the Forty-sixth Yearbook is instrumental skills, such as the ability to make accurate measurements, to read graphs, maps, etc. This will be type three in the present paper. The fifth type of objective listed in the Yearbook is problem solving skills. This includes all of the objectives related to the ability to use the scientific method. These skills have been included in the fourth category of the present classification. Attitudes, appreciations, and interests are the three other types of objectives given in the Yearbook, and are presented here in the fifth, sixth, and seventh categories.

In order to present the objectives in tables and graphs, it seemed advisable to abbreviate these objectives. The abbreviations used are presented in parentheses after the objectives.

Classification of the Thirty-two Objectives of the Rating Sheet

1. Knowledge

    1. To acquire a vocabulary of useful biological terms. (vocabulary)

    2. To acquire knowledge of some of the basic laws of biology. (basic laws)

    3. To become familiar with biological facts which will lead to more healthful living. (healthful living)

    4. To become familiar with biological facts which will contribute toward social good. (social good)

    5. To acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life. (philosophy)

II. Understandings

1. To understand the relation of man to his environment.
(man to environment)

2. To understand the relation of structures to their functions.
(structures to functions)

3. To learn to apply the basic laws of biology.
(apply laws)

4. To learn to distinguish a fact from a theory.
(fact from theory)

III. Instrumental skills

1. To learn to make accurate observations.
(accurate observations)

2. To learn to read and construct graphs and tables.
(graphs and tables)

3. To learn to use scientific apparatus.
(scientific apparatus)

IV. Problem Solving Skills

1. To acquire the ability to detect and state a problem.
(state problem)

2. To learn to formulate hypotheses.
(formulate hypotheses)

3. To acquire the ability to plan experiments to test hypotheses.
(plan experiments)

4. To learn to organize the facts obtained from observations and experiments. (organize facts)

5. To learn to interpret facts, that is, to draw conclusions.
(interpret facts)

6. To learn to transfer the method of scientific thinking to one's own problems and to social problems.
(scientific method)

V. Attitudes

1. To become able to recognize true cause and effect relationships. (cause and effect)

2. To develop an attitude of openmindedness, that is, a willingness to accept the results of objective observations. (openmindedness)

3. To develop freedom from superstition. (freedom from superstition)

4. To develop a willingness to suspend judgment until sufficient facts are gathered. (suspend judgment)

5. To develop freedom from prejudice. (freedom from prejudice)

6. To develop intellectual curiosity. (intellectual curiosity)

VI. Interests

1. To become acquainted with the nature and extent of the professional fields of biology. (professional fields)

2. To acquire a background for avocational reading. (avocational reading)

3. To acquire other avocational interests. (avocational interests)

4. To become familiar with the sources of biological literature. (biological literature)

VII. Appreciations

1. To acquire the ability to recognize important biological problems which are still unsolved. (unsolved problems)

2. To develop an appreciation of the esthetic values of nature. (esthetic values)

3. To appreciate the economic values of biology. (economic values)

4. To develop an appreciation of the efforts, hard work, and accuracy that are necessary in any scientific investigation. (accuracy of science)

There are several of these objectives which might have been placed in two categories. For example, to make accurate observations might be considered an instrumental skill in some instances; it might be considered a step in the scientific method in other instances. To distinguish a fact from a theory might be considered an understanding, or it might be considered a step or a part of the scientific method. Since any classification is a more or less arbitrary grouping, these have been classified according to the category which seemed the most logical to the writer. Others might have made a slightly different allocation of some of these objectives.

CHAPTER IV

RESULTS OF ANALYSIS OF RATING SHEET FOR THE SEVEN GROUPS STUDIED

Comparison of ratings of objectives by the seven groups. In the tables that follow the data collected from the seven groups to whom the rating sheet was presented are given in terms of the total number of responses to each rating and in terms of percentages. The staff of the Department of Biological Science is designated on the following tables and Figures as "staff," while the members of the faculty of Michigan State College to whom the rating sheet was sent is designated as "faculty." The group of students who took biological science the first year it was offered is indicated on the tables and Figures as "seniors." The group indicated on the tables and Figures as "pre" refers to those students beginning the course in biological science, who had not had any previous course in biology at the college level. It will be recalled that the rating sheet was presented at the end of the term to groups of students finishing the first, second, and third terms of the course. Biological science is designated in the Michigan State College catalogue as Basic 121, 122, and 123, therefore the first term group will be called "121," the second term group "122," and the third term group "123," in the following tables and Figures.

There were some people who responded to the questionnaire who did not give any response to certain questions. These have been added to the X rating, which was marked if the respondent did not understand the

meaning of the objective. In most cases there were very few in either of these categories.

The objectives have been grouped in the following tables according to the classification presented in Chapter III. In summarizing the data an attempt has been made to bring out differences and similarities between the various groups studied.

An examination of Tables I - VII shows that there is considerable agreement among the seven groups of ratings on certain of the objectives and much diversity of opinion regarding the importance of other objectives. On those objectives which have been classified as knowledge objectives, and which are presented in Table I, there is considerable agreement in all of the groups when the absolute percentage is used as a basis of comparison. Of the knowledge objectives there is more diversity of opinion on item 4 in Table I (to become familiar with biological facts which will contribute to social good) than on any other of the knowledge objectives. Of the staff of the Department of Biological Science 77 per cent have rated this as a very important objective, whereas about 40 per cent of the four freshmen groups gave this a rating of one. Of the faculty groups and the seniors about 50 per cent believed this to be a very important objective of the course. It is interesting to compare the response on this goal with the responses to objective 3 in Table I (to become familiar with biological facts which will lead to more healthful living). All groups have rated this objective as important, but the staff of the Department of Biological Science has rated knowledge which contribute to social good considerably higher than it has rated knowledge which

TABLE I

COMPARISON OF RATINGS OF KNOWLEDGE OBJECTIVES
BY STUDENT AND FACULTY GROUPS

(1) To acquire a vocabulary of useful biological terms.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	3	11.5	6	23.1	12	46.2	4	15.4	1	3.8	0	-
Faculty	4	7.5	14	26.4	23	43.4	8	15.1	4	7.6	0	-
Seniors	13	15.7	23	27.7	37	44.6	9	10.8	1	1.2	0	-
Pre	40	13.4	72	24.2	99	33.3	50	16.7	36	12.1	1	0.3
121	40	12.3	94	29.0	123	37.9	42	12.9	24	7.3	2	0.6
122	38	12.2	73	23.4	120	38.5	57	18.3	23	7.3	1	0.3
123	35	11.0	80	25.0	118	37.1	61	19.1	22	6.9	3	0.9

* Total number in group; Staff - 26, Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To acquire knowledge of some of the basic laws of biology.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	20	76.9	6	23.1	0	-	0	-	0	-	0	-
Faculty	21	39.6	23	43.4	9	17.0	0	-	0	-	0	-
Seniors	48	56.7	27	32.6	8	9.7	0	-	0	-	0	-
Pre	147	49.4	98	32.9	40	13.4	10	3.3	3	1.0	0	-
121	193	59.4	85	26.2	36	11.1	10	3.0	1	0.3	0	-
122	174	55.8	85	27.3	40	12.9	4	1.2	7	2.2	2	0.6
123	138	43.2	105	32.9	57	17.9	12	3.8	6	1.9	1	0.3

TABLE I (continued)

(3) To become familiar with biological facts which will lead to more healthful living.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	17	65.5	7	26.8	2	7.7	0	-	0	-	0	-
Faculty	34	64.1	9	17.0	5	9.4	3	5.7	2	3.8	0	-
Seniors	60	72.3	12	14.5	8	9.6	3	3.6	0	-	0	-
Pre	186	62.5	75	25.2	27	9.0	7	2.3	3	1.0	0	-
121	245	75.4	50	15.4	22	6.8	4	1.2	4	1.2	0	-
122	221	70.9	51	16.4	29	9.3	7	2.2	3	0.9	1	0.3
123	195	61.1	76	23.8	31	9.7	13	4.1	4	1.3	0	-

(4) To become familiar with biological facts which will contribute toward social good.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	20	77.0	4	15.3	2	7.7	0	-	0	-	0	-
Faculty	27	51.0	12	22.5	8	15.1	4	7.6	0	-	2	3.8
Seniors	41	49.4	25	30.1	10	12.1	4	4.8	1	1.2	2	2.4
Pre	118	39.6	103	34.6	56	18.8	12	4.0	9	3.0	0	-
121	131	40.4	100	30.8	61	18.7	13	4.0	17	5.2	3	0.9
122	132	42.4	89	28.5	70	22.4	15	4.8	5	1.6	1	0.3
123	119	37.4	104	32.6	61	19.1	25	7.8	10	3.1	0	-

(5) To acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	14	53.8	8	30.8	2	7.7	1	3.8	0	-	1	3.9
Faculty	25	47.1	18	34.0	8	15.1	2	3.8	0	-	0	-
Seniors	35	42.2	23	27.7	18	21.7	4	4.8	2	2.4	1	1.2
Pre	98	32.9	85	28.6	71	23.9	23	7.7	15	5.0	6	1.9
121	100	30.8	101	31.1	74	22.8	27	8.3	17	5.2	6	1.8
122	101	32.4	95	30.5	75	24.1	23	7.4	14	4.4	4	1.2
123	107	33.6	90	28.2	66	20.7	25	7.8	25	7.8	6	1.9

contribute to more healthful living, whereas the reverse is true for other groups.

Objective number 5 (Table I), to acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life, is rated as being more important to the older groups, that is, the staff group, the faculty, and the seniors. Age differences in response to objectives will be discussed in more detail in a later chapter.

Knowledge of the basic laws of biology (objective 2, Table I) was considered by all groups to be an important objective. To acquire a vocabulary of useful biological terms (objective 1, Table I) was rated by all groups as being the least important of the knowledge objectives.

The objectives classified as understandings as a group are rated lower than the knowledge objectives (Table II). The objective to understand the relation of man to his environment (objective 1, Table II) is considered by most of the groups to be the most important of the understanding objectives. The staff group has rated this objective higher than any of the student groups has rated it, the faculty group is intermediate in its rating of this objective, between the staff and the students. In contrast, the student groups have rated the objective to understand the relation of structures to their functions (objective 2, Table II) higher than the faculty and staff group have rated this outcome.

It is of particular interest to note that for all groups knowledge of the laws of biology was rated higher than the ability to apply the

TABLE II

COMPARISON OF RATINGS OF UNDERSTANDING OBJECTIVES
BY STUDENT AND FACULTY GROUPS

(1) To understand the relation of man to his environment.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	16	61.5	6	23.1	4	15.4	0	-	0	-	0	-
Faculty	26	49.0	11	20.8	12	22.6	3	5.7	1	1.9	0	-
Seniors	31	37.4	32	38.5	15	18.1	4	4.8	1	1.2	0	-
Pre	96	32.3	107	36.0	73	24.5	13	4.3	8	2.6	1	0.3
121	115	35.4	116	35.7	70	21.6	14	4.3	10	3.0	0	-
122	113	36.4	106	34.0	71	22.7	11	3.5	9	2.8	2	0.6
123	105	32.9	105	32.9	72	22.6	29	9.1	6	1.9	2	0.6

* Total number in group; Staff - 26, Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To understand the relation of structures to their functions.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	4	15.4	9	34.6	11	42.3	1	3.8	0	-	1	3.8
Faculty	9	17.0	20	37.7	10	18.9	6	11.3	3	5.7	5	9.4
Seniors	23	27.7	24	29.0	25	31.1	5	6.0	4	4.8	2	2.4
Pre	56	18.8	92	30.9	96	32.3	37	12.4	10	3.3	7	2.3
121	75	23.1	119	36.7	84	25.9	32	9.8	10	3.0	5	1.5
122	100	32.2	99	31.8	77	24.6	19	6.0	10	3.2	7	2.2
123	73	22.9	99	31.0	94	29.5	35	11.0	8	2.5	10	3.1

TABLE II (continued)

(3) To learn to apply the basic laws of biology.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	14	53.9	7	26.9	4	15.4	0	-	0	-	1	3.8
Faculty	11	20.8	20	37.6	15	28.3	4	7.6	3	5.7	0	-
Seniors	24	28.9	20	24.1	23	27.7	14	16.9	2	2.4	0	-
Pre	39	13.0	59	19.8	106	35.6	62	20.9	29	9.7	3	1.0
121	57	17.6	81	25.0	100	30.8	46	14.1	36	11.0	5	1.5
122	59	19.1	82	26.3	82	26.3	48	15.3	36	11.5	5	1.6
123	59	12.2	84	26.3	101	31.8	62	19.4	31	9.7	2	0.6

(4) To learn to distinguish a fact from a theory.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	17	65.4	4	15.4	4	15.4	1	3.8	0	-	0	-
Faculty	21	39.5	19	35.9	7	13.2	2	3.8	2	3.8	2	3.8
Seniors	21	25.3	30	36.2	23	27.7	5	6.0	3	3.6	1	1.2
Pre	80	26.1	95	31.9	78	26.1	34	11.4	9	3.0	2	0.6
121	81	25.0	101	31.1	90	27.7	32	9.8	21	6.4	0	-
122	67	21.5	103	33.1	87	27.9	38	12.2	14	4.4	3	0.9
123	62	19.4	100	31.3	102	32.1	33	10.3	17	5.3	5	1.6

laws. For the student groups these differences were high. Whereas about 50 per cent of the students felt that knowledge of principles was a very important objective of biology, only about 15 per cent of them believed that application of these laws was a very important aim. One wonders why the student thinks it is important to learn the laws, if he does not feel that they are useful, and why students are, generally speaking, so concerned about learning what is practical and useful.

The understanding objective rated highest by the staff group was to learn to distinguish a fact from a theory (objective 4, Table II). The faculty group considered this of less importance than the staff group considered it, and the student groups considered it of less importance than the faculty group. Because the members of the staff of biological science are particularly interested in those phases of science teaching related to the teaching of the scientific method, and since this objective is dependent on an understanding of the scientific method, it is probably to be expected that this objective would be rated considerably higher by the staff group than by the other groups.

The responses on instrumental skill are probably the most interesting of the entire study (Table III). To make accurate observations (objective I, Table III) was rated the highest of any of the objectives by the staff of biological science, and was rated high by all of the other groups. However, the ability to use instruments which increase the accuracy of observations (objective 3, Table III) was the lowest ranking of all of the objectives rated by the members of the biology staff, and was rated very low by all of the other groups. Hunter and

TABLE III

COMPARISON OF RATINGS OF INSTRUMENTAL SKILL OBJECTIVES BY STUDENT AND FACULTY GROUPS

(1) To learn to make accurate observations.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	23	88.5	3	11.5	0	-	0	-	0	-	0	-
Faculty	35	66.0	9	17.0	7	13.2	2	3.8	0	-	0	-
Seniors	36	43.4	29	34.9	14	16.9	4	4.8	0	-	0	-
Pre	153	51.4	84	28.1	47	15.7	9	3.0	4	1.3	1	0.3
121	164	50.4	99	30.0	40	12.3	10	3.0	12	3.6	0	-
122	139	44.6	102	32.7	47	15.1	13	4.1	11	3.5	0	-
123	149	46.7	101	31.7	51	16.0	10	3.1	8	2.5	0	-

* Total number in group; Staff - 26; Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To learn to read and construct graphs and tables.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	3	11.5	12	46.2	5	19.2	3	11.5	2	7.7	1	3.8
Faculty	5	9.4	10	18.9	14	26.5	12	22.6	12	22.6	0	-
Seniors	1	1.2	5	6.0	34	41.0	17	20.5	25	30.1	1	1.2
Pre	15	5.0	41	13.7	73	24.4	80	26.1	86	28.9	2	0.9
121	16	4.9	32	9.8	108	33.3	67	20.6	102	31.2	0	-
122	15	4.9	45	14.5	76	24.4	71	22.8	104	33.4	1	0.3
123	8	2.5	24	7.5	59	18.5	84	26.3	142	44.5	2	0.6

(3) To learn to use scientific apparatus.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	3	11.5	1	3.9	8	30.8	9	34.6	5	19.2	0	-
Faculty	5	9.4	12	22.6	19	35.9	9	17.0	6	11.3	2	3.8
Seniors	2	2.4	16	19.3	31	37.4	25	30.1	8	9.6	1	1.2
Pre	62	20.8	68	22.8	96	32.2	39	13.0	33	11.0	0	-
121	40	12.3	80	24.6	103	31.6	61	18.7	41	12.6	0	-
122	41	13.4	63	20.1	105	33.6	61	19.5	42	13.4	0	-
123	30	9.0	51	16.0	105	32.9	71	22.3	62	19.4	0	-

Spore[1] found that the objective "to help to develop the power of observation" rated very high in their study. They were surprised to find that this was true, because, as they say in their report: "Just what is meant by this is difficult to state, but the writers had placed this objective in the list as a "buffer," believing it to be a by-product rather than a real objective of science in the secondary school. Evidently the teachers consider it a very worth while objective."[2] The present writer is also unable to understand the position of this objective in the rating. If it is an objective of major importance it would seem logical that this objective be tested, and as far as the writer knows, none of the staff, nor the examining board make any attempt to evaluate this objective directly.

The ability to read and construct graphs and tables (objective 2, Table III), another of the instrumental skills, was consistently rated by the students as a very minor objective. In fact, all of the student groups gave this the lowest of ratings. Whether the student believes that it is unimportant to know how to read and construct graphs and tables, or whether he believes that the teaching of techniques is not a function of the biology teacher cannot, of course, be determined from the data.

As indicated in Table IV, all objectives related to the scientific method were considered to be very important by the members of the Department of Biological Science while the students considered these to be

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[1] Hunter and Spore, op. cit., p. 639.

[2] Loc. cit.

TABLE IV

COMPARISON OF PROBLEM SOLVING SKILL OBJECTIVES
BY STUDENT AND FACULTY GROUPS

(1) To acquire the ability to detect and state a problem.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	19	73.1	6	23.1	1	3.8	0	-	0	-	0	-
Faculty	17	32.0	19	35.8	10	18.9	3	5.7	4	7.6	0	-
Seniors	12	14.5	22	26.5	28	33.7	12	14.5	8	9.6	1	1.2
Pre	69	23.2	75	25.2	80	26.8	36	12.1	33	11.1	5	1.6
121	101	31.1	101	31.1	65	20.0	30	9.2	26	8.0	2	0.6
122	101	32.4	71	22.8	67	21.5	43	13.8	29	9.2	1	0.3
123	74	23.2	82	25.7	79	24.8	54	16.9	24	7.5	6	1.9

* Total number in group; Staff - 26, Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To learn to formulate hypotheses.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	17	65.4	6	23.1	2	7.7	0	-	1	3.8	0	-
Faculty	14	26.4	14	26.4	13	24.6	5	9.4	7	13.2	0	-
Seniors	10	12.1	23	27.7	27	32.5	15	18.1	7	8.4	1	1.2
Pre	63	21.4	101	33.8	67	22.4	43	14.4	20	6.7	4	1.3
121	102	31.4	91	28.1	76	23.3	39	12.0	17	5.2	0	-
122	94	30.2	74	23.8	80	25.7	34	10.8	28	8.9	2	0.6
123	71	22.3	83	26.0	95	29.7	34	10.7	36	11.3	0	-

(3) To acquire the ability to plan experiments to test hypotheses.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	15	57.7	5	19.2	4	15.4	2	7.7	0	-	0	-
Faculty	10	18.9	11	20.8	15	28.3	5	9.4	12	22.6	0	-
Seniors	6	7.2	20	24.1	25	30.1	17	20.5	15	18.1	0	-
Pre	43	14.5	93	31.3	65	21.9	60	20.2	29	9.7	7	2.3
121	60	18.5	99	30.5	88	27.1	55	16.9	23	7.0	0	-
122	49	15.7	80	25.7	89	28.6	49	15.7	43	13.7	2	0.6
123	37	11.6	74	23.2	103	32.3	58	18.2	44	13.8	3	0.9

TABLE IV (continued)

(4) To learn to organize facts obtained from observations and experiments.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	22	84.6	3	11.5	0	-	0	-	0	-	1	3.9
Faculty	28	52.8	10	18.9	7	13.2	6	11.3	2	3.8	0	-
Seniors	17	20.5	40	48.2	18	21.7	8	9.6	0	-	0	-
Pre	108	36.3	99	33.3	65	21.8	15	5.0	10	3.3	1	0.3
121	117	36.1	123	37.8	54	16.6	16	4.9	14	4.3	1	0.3
122	109	35.0	103	33.1	67	21.5	19	6.0	14	4.4	0	-
123	92	28.9	111	34.8	83	26.0	18	5.6	11	3.4	4	1.3

(5) To learn to interpret facts.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	21	80.8	4	15.4	1	3.8	0	-	0	-	0	-
Faculty	31	58.5	12	22.6	5	9.4	4	7.6	1	1.9	0	-
Seniors	22	26.5	35	42.2	21	25.3	2	2.4	3	3.6	0	-
Pre	117	39.3	103	34.6	56	18.8	15	5.0	7	2.3	0	-
121	128	39.4	104	32.0	58	17.8	26	8.0	9	2.8	0	-
122	113	36.4	101	32.3	64	20.5	20	6.4	13	4.1	1	0.3
123	92	28.8	131	41.1	72	22.6	14	4.4	10	3.1	0	-

(6) To learn to transfer the method of scientific thinking to one's own problems and to social problems.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	19	73.1	5	19.2	1	3.8	0	-	0	-	1	3.8
Faculty	27	50.9	13	24.5	9	17.0	2	3.8	2	3.8	0	-
Seniors	30	36.1	31	37.4	12	14.5	7	8.4	3	3.6	0	-
Pre	109	36.6	90	30.3	74	24.8	18	6.0	6	2.0	1	0.3
121	114	35.1	102	31.4	70	21.6	24	7.3	15	4.6	0	-
122	102	32.7	102	32.7	80	25.7	20	6.4	8	2.5	0	-
123	110	34.5	93	29.2	76	23.8	26	8.2	11	3.4	3	0.9

moderately important objectives. In most instances the faculty group was intermediate between the staff and students in its rating of these objectives. In general the seniors have rated these objectives lower than any of the other groups rated them. It will be recalled that the senior group was largely female in composition; this may have affected the ratings of these objectives. Sex differences will be discussed in Chapter V.

An inspection of Table IV gives evidence that those objectives related to the organization of data and its interpretation are considered by all groups to be the most important phases of the scientific method, and the ability to plan experiments the least important.

As mentioned previously all groups gave a high rating to the ability to make accurate observations. An interesting point is that all of the groups rated the ability to organize facts obtained from observations (objective 4, Table IV) and the ability to interpret facts (objective 5, Table IV) lower than the ability to make the observations. Again one wonders what good the facts are to the individual if they are not organized and interpreted.

The scientific attitudes were all rated as being more important objectives by the staff of biological science than by any other group as is seen in Table V. The faculty group is consistently between the staff group and the student group in their rating of these objectives. However, over 40 per cent of the students felt that an attitude of openmindedness (objective 2, Table V) was a very important objective of biological science, and less than four per cent felt that it was a very unimportant

TABLE V

COMPARISON OF RATINGS OF ATTITUDE OBJECTIVES
BY STUDENT AND FACULTY GROUPS

(1) To become able to recognize true cause and effect relationships.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	20	76.9	4	15.4	2	7.7	0	-	0	-	0	-
Faculty	30	56.6	13	24.5	7	13.2	2	3.8	1	1.9	0	-
Seniors	30	36.2	25	30.1	19	22.9	5	6.0	4	4.8	0	-
Pre	101	33.9	83	27.9	59	19.8	23	7.7	28	9.4	4	1.3
121	121	37.3	85	26.2	68	20.9	27	8.3	22	6.7	2	0.6
122	101	32.4	85	27.3	64	20.6	32	10.2	22	7.0	8	2.5
123	102	32.1	96	29.6	71	22.4	19	6.1	24	7.6	7	2.2

* Total number in group; Staff - 26; Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To develop an attitude of openmindedness.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	23	88.5	2	7.7	0	-	1	3.8	0	-	0	-
Faculty	20	58.4	14	26.4	4	7.6	2	3.8	2	3.8	0	-
Seniors	33	39.8	29	34.9	15	18.1	2	2.4	2	2.4	2	2.4
Pre	100	33.6	79	26.6	62	20.9	31	10.3	15	5.0	11	3.6
121	149	45.9	104	32.1	46	14.2	12	3.6	11	3.3	3	0.9
122	131	42.0	97	31.1	55	17.7	18	5.8	7	2.2	4	1.2
123	138	43.3	104	32.6	46	14.4	21	6.6	8	2.5	2	0.6

(3) To develop freedom from superstition.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	15	57.7	8	30.8	2	7.7	1	3.8	0	-	0	-
Faculty	20	39.5	10	18.8	8	15.0	6	11.6	7	13.2	1	1.9
Seniors	20	24.1	15	18.1	18	21.7	12	14.5	18	21.7	0	-
Pre	50	16.7	39	13.0	65	21.9	41	13.8	102	34.2	1	0.3
121	81	24.9	52	16.1	64	19.7	42	12.8	62	19.0	4	1.2
122	82	26.2	50	16.0	74	23.6	34	10.8	68	21.7	4	1.2
123	76	23.8	53	16.5	76	23.8	47	14.7	62	19.4	5	1.6

TABLE V (continued)

(4) To develop a willingness to suspend judgment until sufficient facts are gathered.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	22	84.6	3	11.5	1	3.8	0	-	0	-	0	-
Faculty	33	62.2	11	20.8	5	9.4	3	5.7	1	1.9	0	-
Seniors	33	39.8	27	32.5	15	18.1	6	7.2	1	1.2	1	1.2
Pre	83	27.9	102	34.3	77	25.9	26	8.7	8	2.6	2	0.6
121	132	40.7	110	33.9	56	17.2	18	5.5	8	2.4	1	0.3
122	103	33.1	107	34.3	76	24.4	15	4.8	9	2.8	2	0.6
123	101	31.7	124	38.8	68	21.3	13	4.1	8	2.5	5	1.6

(5) To develop freedom from prejudice.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	20	77.0	5	19.2	0	-	0	-	1	3.8	0	-
Faculty	23	43.4	12	22.6	9	17.0	6	11.3	1	1.9	2	3.8
Seniors	24	28.9	22	26.5	14	16.9	9	10.8	13	15.7	1	1.2
Pre	87	29.2	54	18.2	58	19.5	41	13.7	52	17.5	6	1.9
121	107	33.0	72	22.2	60	18.4	31	9.5	52	16.0	3	0.9
122	88	28.3	71	22.9	65	20.8	33	10.5	47	15.0	8	2.5
123	90	28.2	79	24.8	66	20.7	49	12.5	37	11.6	7	2.2

(6) To develop intellectual curiosity.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	17	65.5	7	26.8	2	7.7	0	-	0	-	0	-
Faculty	27	50.9	13	24.5	10	18.9	2	3.8	1	1.9	0	-
Seniors	32	38.6	20	24.1	19	22.9	6	7.2	5	6.0	1	1.2
Pre	97	32.6	96	32.3	54	18.2	28	9.3	20	6.7	3	0.9
121	114	35.1	92	28.4	73	22.5	25	7.6	20	6.1	1	0.3
122	99	31.9	81	25.7	80	25.7	31	10.0	19	6.1	2	0.6
123	78	24.5	110	34.4	81	25.4	34	10.7	14	4.4	2	0.6

objective. A willingness to suspend judgment until sufficient facts are available (objective 4, Table V) and an ability to recognize true cause and effect relationships (objective 1, Table V) are rated by all groups as being important objectives of biological science.

An inspection of Table V shows that there is considerable diversity of student opinion regarding the importance of the objectives to develop freedom from superstition, and to develop freedom from prejudice. An examination of Tables I-VII gives evidence of considerable uniformity of opinion within each group. In general, the curves plotted from the data would be unimodal. In the case of the objective to develop freedom from superstition, however, there appears to be no true mode. The plotted data would approximate a straight line.

In general, those objectives which were classified as interests (Table VI) and those classified as appreciations (Table VII), were considered less important objectives than the objectives classified in the other categories. Very few persons in any of the groups have given these a high rating. In most instances the majority has indicated their belief that these are objectives of average importance. The propaedeutic functions of biology (objective 1, Table VI) were considered to be either relatively unimportant or of average importance by all groups. It is interesting to note that the students rated this function of biology slightly higher than the members of the Department of Biological Science rated it. It is surprising to observe that none of the groups considered that the avocational aspects of biology (objectives 2 and 3, Table VI) were very important aspects of the course. The majority of all groups

TABLE VI

COMPARISON OF RATINGS OF INTEREST OBJECTIVES
BY STUDENT AND FACULTY GROUPS

(1) To become acquainted with the nature and extent of the professional fields of biology.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	1	3.8	5	19.2	7	26.9	10	38.5	3	11.5	0	-
Faculty	5	9.4	10	18.9	21	39.6	6	11.3	10	18.9	1	1.9
Seniors	10	12.1	14	16.9	23	39.8	20	24.1	6	7.2	0	-
Pre	44	14.7	68	22.8	85	28.5	52	17.4	45	15.1	3	1.0
121	33	10.1	54	16.6	106	32.6	70	21.5	61	18.7	1	0.3
122	44	14.1	55	17.6	91	29.1	69	22.1	51	16.3	2	0.6
123	25	7.8	38	11.9	125	39.2	76	23.8	53	16.6	2	0.6

* Total number in group; Staff - 26; Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To acquire a background for avocational reading.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	1	3.8	4	15.4	14	53.9	5	19.2	2	7.7	0	-
Faculty	2	3.8	6	11.3	20	37.8	12	22.6	12	22.6	1	1.9
Seniors	6	7.2	12	14.5	29	34.9	23	27.7	12	14.6	1	1.2
Pre	14	4.6	54	18.2	89	29.9	84	28.2	50	16.8	7	2.3
121	12	3.6	53	16.4	113	34.8	77	23.7	65	20.0	5	1.5
122	30	9.6	46	14.7	97	31.1	62	19.9	67	21.5	10	3.2
123	12	3.8	41	12.9	84	26.3	83	26.0	88	27.6	11	3.4

TABLE VI (continued)

(3) To acquire other avocational interests.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	1	3.8	6	23.1	10	38.5	8	30.8	1	3.8	0	-
Faculty	1	1.9	9	17.0	19	35.9	13	24.5	9	17.0	2	3.8
Seniors	5	6.0	8	9.6	27	32.5	30	36.2	12	14.5	1	1.2
Pre	13	4.3	47	15.7	97	32.6	76	25.6	58	19.5	7	2.3
121	13	4.0	39	12.0	107	33.3	86	26.4	73	22.4	6	1.8
122	15	4.8	46	14.7	85	27.3	92	29.5	70	22.5	4	1.2
123	5	1.6	31	9.7	105	32.9	100	31.3	74	23.2	4	1.3

(4) To become familiar with the sources of biological literature.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	5	19.2	1	3.8	9	34.6	9	34.6	2	7.7	0	-
Faculty	5	9.4	7	13.2	18	34.0	8	15.1	14	26.4	1	1.9
Seniors	4	4.8	11	13.3	26	31.3	27	32.5	14	16.9	1	1.2
Pre	11	3.6	44	14.8	89	29.9	82	27.6	70	23.5	2	0.6
121	14	4.3	52	16.0	97	29.9	73	22.4	89	27.4	0	-
122	29	9.2	33	10.6	82	26.3	90	28.9	76	24.4	2	0.6
123	7	2.2	40	12.5	91	28.5	83	26.0	94	29.5	4	1.2

TABLE VII

COMPARISON OF RATINGS OF APPRECIATION OBJECTIVES
BY STUDENT AND FACULTY GROUPS

(1) To acquire the ability to recognize important biological problems which are still unsolved.

	Ratings											
	1		2		3		4		5		X	
Groups*	N	%	N	%	N	%	N	%	N	%	N	%
Staff	6	23.1	11	42.3	3	11.5	5	19.2	1	3.8	0	-
Faculty	4	7.6	10	18.9	21	39.5	10	18.9	7	13.2	1	1.9
Seniors	15	18.1	22	26.5	24	28.9	9	10.8	13	15.7	0	-
Pre	82	27.7	72	24.2	73	24.5	44	14.8	26	8.8	0	-
121	58	17.8	94	29.0	94	29.0	42	12.9	36	11.0	1	0.3
122	55	17.6	76	24.4	89	28.6	51	16.3	36	11.5	5	1.6
123	56	17.6	86	27.0	76	23.7	50	15.7	47	14.7	4	1.3

* Total number in group; Staff - 26; Faculty - 53; Seniors - 83; pre-group - 298; 121 group - 325; 122 group - 312; 123 group - 319.

(2) To develop an appreciation of the esthetic values of nature.

	Ratings											
	1		2		3		4		5		X	
Groups	N	%	N	%	N	%	N	%	N	%	N	%
Staff	1	3.8	5	19.2	13	50.0	4	15.4	3	11.5	0	-
Faculty	1	1.9	11	20.8	19	35.8	13	24.5	8	15.1	1	1.9
Seniors	6	7.2	10	12.1	25	30.1	22	26.5	20	24.1	0	-
Pre	39	13.2	54	18.1	94	31.6	71	23.9	34	11.4	6	2.0
121	14	4.3	37	11.4	107	32.9	74	22.8	84	25.8	9	2.8
122	29	9.3	43	13.8	90	28.9	61	19.5	81	26.0	8	2.5
123	9	2.8	30	9.4	83	26.0	101	31.7	98	27.9	7	2.2

TABLE VII (continued)

(3) To appreciate the economic values of biology.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	2	7.7	8	30.8	7	26.9	7	26.9	2	7.7	0	-
Faculty	6	11.3	9	17.0	20	37.7	11	20.8	6	11.3	1	1.9
Seniors	9	10.8	19	22.9	30	36.2	9	10.8	11	13.3	5	6.0
Pre	25	8.3	75	25.2	103	34.6	66	22.2	23	7.8	6	1.9
121	25	7.6	92	28.4	96	29.6	66	20.3	40	12.3	6	1.8
122	25	8.0	64	20.6	102	35.9	67	21.5	39	12.4	5	1.6
123	24	7.4	82	25.6	105	32.8	56	17.5	45	14.5	7	2.2

(4) To develop an appreciation of the efforts, hard work, and accuracy that are necessary in any scientific investigation.

Groups	Ratings											
	1		2		3		4		5		X	
	N	%	N	%	N	%	N	%	N	%	N	%
Staff	9	34.6	3	11.5	9	34.6	3	11.5	2	7.7	0	-
Faculty	10	18.9	14	26.3	18	34.0	7	13.2	4	7.6	0	-
Seniors	7	8.4	20	24.0	32	38.5	17	20.4	7	8.7	0	-
Pre	46	15.4	85	28.6	98	32.9	48	16.2	19	6.3	2	0.6
121	55	16.9	92	28.3	107	33.0	40	12.3	29	8.9	2	0.6
122	50	16.0	87	27.9	98	31.5	44	14.1	30	9.6	3	0.9
123	42	13.2	76	23.8	99	31.1	70	21.9	32	10.0	0	-

rated this as average in importance.

It is rather interesting to observe that the objectives to acquire the ability to recognize important biological problems which are still unsolved (objective I, Table VII) and to develop an appreciation of the efforts, hard work, and accuracy necessary for scientific investigation (objective 4, Table VII) were considered by almost all of the groups to be the most important of the appreciation objectives. These objectives are certainly of considerable importance to professional biologists but the writer was surprised that these objectives should be considered more important by the students than an appreciation of the economic values of biology (objective 3, Table VII) which might have a more direct bearing on their own welfare.

A portion of the data presented in Tables I-VII is presented graphically in Figure 1. The student groups were in most cases very similar. The 121 group was chosen as the most representative group of students because the other groups were somewhat more selected. The 122 and 123 groups were not used because (1) many of students who are especially well prepared or who do particularly well in the course take the comprehensive examination early, (2) some of the poorer students have failed the course and many of these poorer students have dropped out of school. The senior group was not representative because the group had had experiences not shared by the freshmen, the group of students who had not yet taken the course most of whom had been in college only a few days did not seem to be a logical group to choose to represent college students. Major differences in the student groups will be discussed

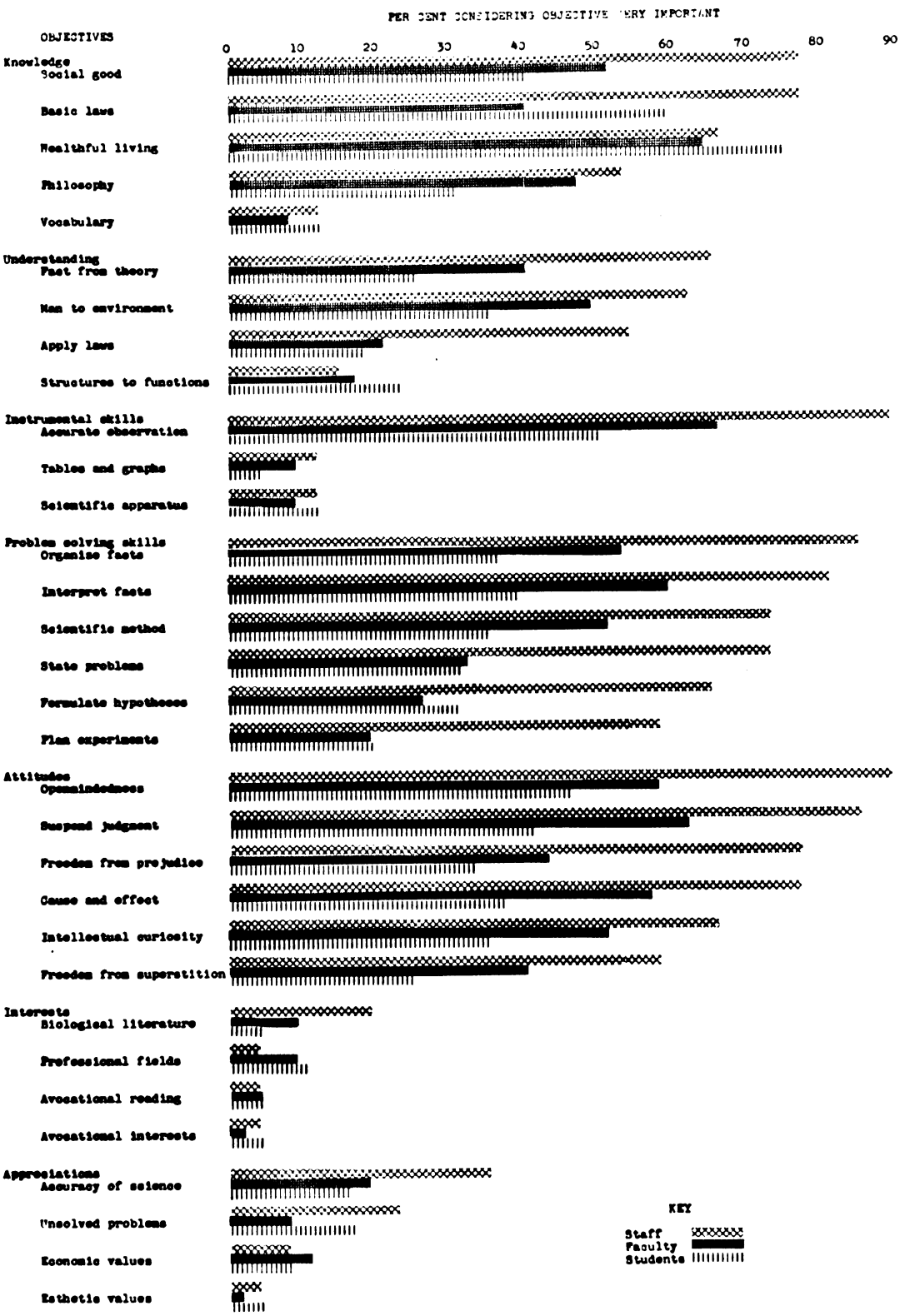
later in the chapter. A valid criticism might be made, however, namely, that there were very few women in this group, but the same criticism could be leveled at the 122 group, which would be the only other logical group to use. The other two groups presented in Figure 1 are the staff group and the faculty group. Since both of these groups are also predominantly male in composition, perhaps the criticism of the group chosen is not as much of a drawback as might at first seem the case.

The per cent of individuals giving each objective a one rating was used as the basis of comparison for Figure 1. The percentage rating the objective either very important or quite important might have been added together and the graph made on this basis, and in several instances this would have been a better index of the importance of the objective. This method was discarded because in several instances all of the staff ratings were in these two categories and this would have made several objectives rated as important by one hundred per cent of the group, thus differences which were apparent in the data would have been lost.

The objectives have been grouped in this graph according to the classification of objectives presented in Chapter III. In order to present all of the objectives on one graph (which seemed very desirable in order that an overview of all of the objectives could be obtained) it was necessary to abbreviate the objectives as described in Chapter III. For each type of objective the objectives are arranged in order of their importance to the staff group. Figure 1 shows clearly that almost all of the objectives are considered more important by the staff of the Department of Biological Science than by any of the other groups. The

FIGURE 1

PERCENTAGE OF STAFF, FACULTY, AND STUDENTS
CONSIDERING OBJECTIVES VERY IMPORTANT


PER CENT CONSIDERING OBJECTIVE VERY IMPORTANT
OBJECTIVES
0
10
20
30
40
50
60
70
80
90
Knowledge
Social good
Basic laws
Healthful living
Philosophy
Vocabulary
Understanding
Fact from theory
Man to environment
Apply laws
Structures to functions
Instrumental skills
Accurate observation
Tables and graphs
Scientific apparatus
Problem solving skills
Organize facts
Interpret facts
Scientific method
State problems
Formulate hypotheses
Plan experiments
Attitudes
Openmindedness
Suspend judgment
Freedom from prejudice
Cause and effect
Intellectual curiosity
Freedom from superstition
Interests
Biological literature
Professional fields
Avocational reading
Avocational interests
Appreciations
Accuracy of science
Unsolved problems
Economic values
Esthetic values
KEY
Staff
Faculty
Students

outstanding exception to this is in the importance of biological information leading to healthful living.

Why does the staff consider most of the objectives to be more important than other groups consider them? One suspects that in any course the objectives are more important to the instructors who have studied them and are teaching them than they are to any other group. In general, the faculty group considered most of the objectives more important than the students considered them. It is of interest to note, however, that the students consider a knowledge of the basic laws of biology a more important objective than the faculty group considers it. As is evident from an inspection of Figure 1 the ratings of all groups are rather similar on knowledge objectives, whereas there is considerable discrepancy between the staff and student groups in the ratings of all of the scientific method skills and most of the scientific attitudes.

In Table VIII are presented the averages of the ratings and the rank of each objective for each of the groups. In this table the objectives are listed in order of their importance to the staff of biological science. This method of presentation of the data gives a more direct comparison of the ranking of the objectives than the method of percentages but the absolute rating in terms of its importance to various groups is lost in this method. For this reason it seemed desirable to present both methods of analysis.

The average of the averages was calculated for each group. These are presented in Table VIII. As can be seen in this table the mean of the averages of the ratings of the members of the department of biological

TABLE VIII

AVERAGES OF RATINGS AND RANKINGS OF OBJECTIVES
BY SEVEN GROUPS IN ORDER OF IMPORTANCE OF OBJECTIVES TO STAFF GROUP

	Groups						
Objectives	Staff	Fac.	Srs.	Pre	121	122	123
Accurate observations							
Average	1.12	1.54	1.83	1.74	1.79	1.89	1.83
Rank	1	2	4	2½	3	3	2
Organize facts							
Average	1.13	1.94	2.20	2.05	2.03	2.12	2.19
Rank	2	14	13	6	7½	9	10
Openmindedness							
Average	1.18	1.47	1.90	2.24	1.86	1.94	1.92
Rank	3½	1	5	10½	4	4	4
Suspend judgment							
Average	1.18	1.64	1.96	2.24	1.96	2.10	2.05
Rank	3½	3	7½	10½	5	7½	5
Interpret facts							
Average	1.23	1.72	2.14	1.97	2.03	2.10	2.12
Rank	5½	6	11	5	7½	7½	7
Basic laws							
Average	1.23	1.77	1.51	1.74	1.59	1.66	1.88
Rank	5½	8	2	2½	2	2	3
Transfer scientific method							
Average	1.28	1.85	2.06	2.06	2.15	2.13	2.16
Rank	7	11	9	7	10	10	9
Social good							
Average	1.31	1.78	1.75	1.96	2.02	1.95	2.07
Rank	9	9	3	4	6	5	6
Cause and effect							
Average	1.31	1.70	2.13	2.30	2.21	2.31	2.25
Rank	9	5	10	13	11½	13	11
State problems							
Average	1.31	2.21	2.83	2.62	2.32	2.45	2.59
Rank	9	16	20	18	14½	16½	17
Freedom from prejudice							
Average	1.35	2.01	2.57	2.71	2.53	2.61	2.54
Rank	11	15	18	20½	18	18	16
Intellectual curiosity							
Average	1.42	1.81	2.17	2.25	2.21	2.32	2.36
Rank	12½	10	12	12	11½	14	13
Healthful living							
Average	1.42	1.68	1.45	1.54	1.38	1.45	1.61
Rank	12½	4	1	1	1	1	1
Formulate hypotheses							
Average	1.54	2.57	3.32	2.51	2.32	2.44	2.63
Rank	14½	20	28	16	14½	15	18
Man to environment							
Average	1.54	1.91	1.93	2.09	2.04	2.02	2.14
Rank	14½	12	6	8	9	6	8

Objectives		Groups						
		Staff	Fac.	Srs.	Pre	121	122	123
Fact from theory	Average	1.58	1.92	2.26	2.31	2.42	2.45	2.50
	Rank	16½	13	14	14	17	16½	15
Freedom from superstition	Average	1.58	2.32	2.91	3.36	2.66	2.85	2.87
	Rank	16½	17	21	29	20	22½	21
Philosophy	Average	1.60	1.75	1.96	2.22	2.25	2.20	2.27
	Rank	18½	7	7½	9	13	12	12
Apply laws	Average	1.60	2.39	2.40	2.94	2.75	2.74	2.88
	Rank	18½	18	16	24	24	20	22
Plan experiments	Average	1.74	2.96	3.18	2.78	2.64	2.86	2.99
	Rank	20	23	25	22	19	24	24
Structures to functions	Average	2.36	2.46	2.30	2.49	2.35	2.14	2.37
	Rank	21	19	15	15	16	11	14
Unsolved problems	Average	2.38	3.11	2.80	2.52	2.70	2.79	2.83
	Rank	22	27	19	17	22	21	19
Accuracy of science	Average	2.46	2.64	2.96	2.69	2.68	2.73	2.92
	Rank	23½	21	23	19	21	19	23
Tables and graphs	Average	2.56	3.30	3.73	3.60	3.61	3.66	4.03
	Rank	23½	28	32	32	32	32	32
Vocabulary	Average	2.77	2.83	2.54	2.90	2.73	2.85	2.85
	Rank	25	22	17	23	23	22½	20
Economic values	Average	2.96	3.04	2.92	2.96	3.01	3.00	3.05
	Rank	26	25	22	26	26	25½	25
Avocational interests	Average	3.08	3.39	3.44	3.55	3.52	3.51	3.66
	Rank	27½	31	29½	31	30	31	29
Biological literature	Average	3.08	3.39	3.44	3.53	3.53	3.40	3.69
	Rank	27½	30	29½	30	31	30	30
Esthetic values	Average	3.12	3.31	3.48	3.02	3.50	3.40	3.88
	Rank	29½	29	31	27	29	29	31
Avocational reading	Average	3.12	3.50	3.28	3.28	3.40	3.30	3.62
	Rank	29½	32	27	28	28	28	28
Professional fields	Average	3.48	3.06	2.98	2.95	3.22	3.09	3.30
	Rank	31	26	24	25	27	27	27
Scientific apparatus	Average	3.65	2.98	3.26	2.71	2.94	3.00	3.26
	Rank	32	24	26	20½	25	25½	26
Average of averages		1.96	2.43	2.56	2.56	2.51	2.55	2.67

science is much higher than the other means of the average ratings. This higher average shows clearly that in general the objectives were rated higher by the staff group than by any of the other groups. It is, however, interesting to note that the range of averages of ratings is greater in the staff group than the ranges of the other groups, that is, the staff thought that some of the objectives were very important, some quite unimportant, whereas the other groups rated all objectives more nearly equal in importance. The staff, being more concerned with the objectives of the course than any of the other groups, was probably more discriminating.

The mean of the averages of the ratings is lowest for the 123 group. This may be due to the fact that after three terms the students were tiring of the course and hence rated the objectives somewhat lower than the other student groups had rated them.

The most important objectives to the staff group can easily be seen in Table VIII, but it is somewhat more difficult to determine the most important objectives to the students without careful scrutiny of this table, so a second table showing these same objectives ranked in order of their importance to the students is included. For this table (Table IX) it seemed advisable to combine the rankings of the three groups of students who had finished one, two, and three terms of the course in biological science because, as may be seen from an inspection of Table VIII, these rankings are very similar.

As is evident from an inspection of Table VIII, the objectives ranked in the first ten places by the biological science staff are principally scientific method objectives. Of the first ten, four are

TABLE IX

RANKINGS OF OBJECTIVES BY FIVE GROUPS
IN ORDER OF IMPORTANCE OF OBJECTIVES TO STUDENTS

Objectives	Groups				
	Students	pre	Seniors	Faculty	Staff
Healthful living	1	1	1	4	12½
Basic laws	2	2½	2	8	5½
Accurate observations	3	2½	4	2	1
Openmindedness	4	10½	5	1	3½
Suspend judgment	5	10½	7½	3	3½
Social good	6	4	3	9	9
Interpret facts	7	5	11	6	5½
Man to environment	8	8	6	12	14½
Organize facts	9	6	13	14	3
Scientific method	10	7	9	11	7
Cause and effect	11	13	10	5	9
Philosophy	12	9	7½	7½	18½
Intellectual curiosity	13	12	12	10	12½
Structure to function	14	15	15	19	21
Formulate hypotheses	15	16	28	20	14½
State problems	16	18	20	16	9
Fact from theory	17	14	14	13	16½
Freedom from prejudice	18	20½	18	15	11
Unsolved problems	19	29	21	17	16½
Accuracy of science	20	23	17	22	23½
Freedom from superstition	21	17	19	27	22
Vocabulary	22	19	23	21	25
Apply laws	23	24	16	18	18½
Plan experiments	24	22	25	23	20
Scientific apparatus	25	20½	26	24	32
Economic values	26	26	22	25	26
Professional fields	27	25	24	26	31
Avocational reading	28	28	27	32	29½
Esthetic values	29	27	31	29	29½
Avocational interests	30	31	29½	31	27½
Biological literature	31	30	29½	30	27½
Tables and graphs	32	32	32	28	23½

scientific method objectives, one is: to make accurate observations, which was classified as an instrumental skill although it might have been considered a scientific method objective, three were scientific attitudes, two were knowledge objectives. Seven of the objectives ranked in the first ten places by the staff were also among the objectives which were ranked as the ten most important by the faculty group. Of the ten highest ranked objectives of the seniors seven were also ranked among the top ten by the staff. The students ranked eight of the same objectives as the faculty among their top ten.

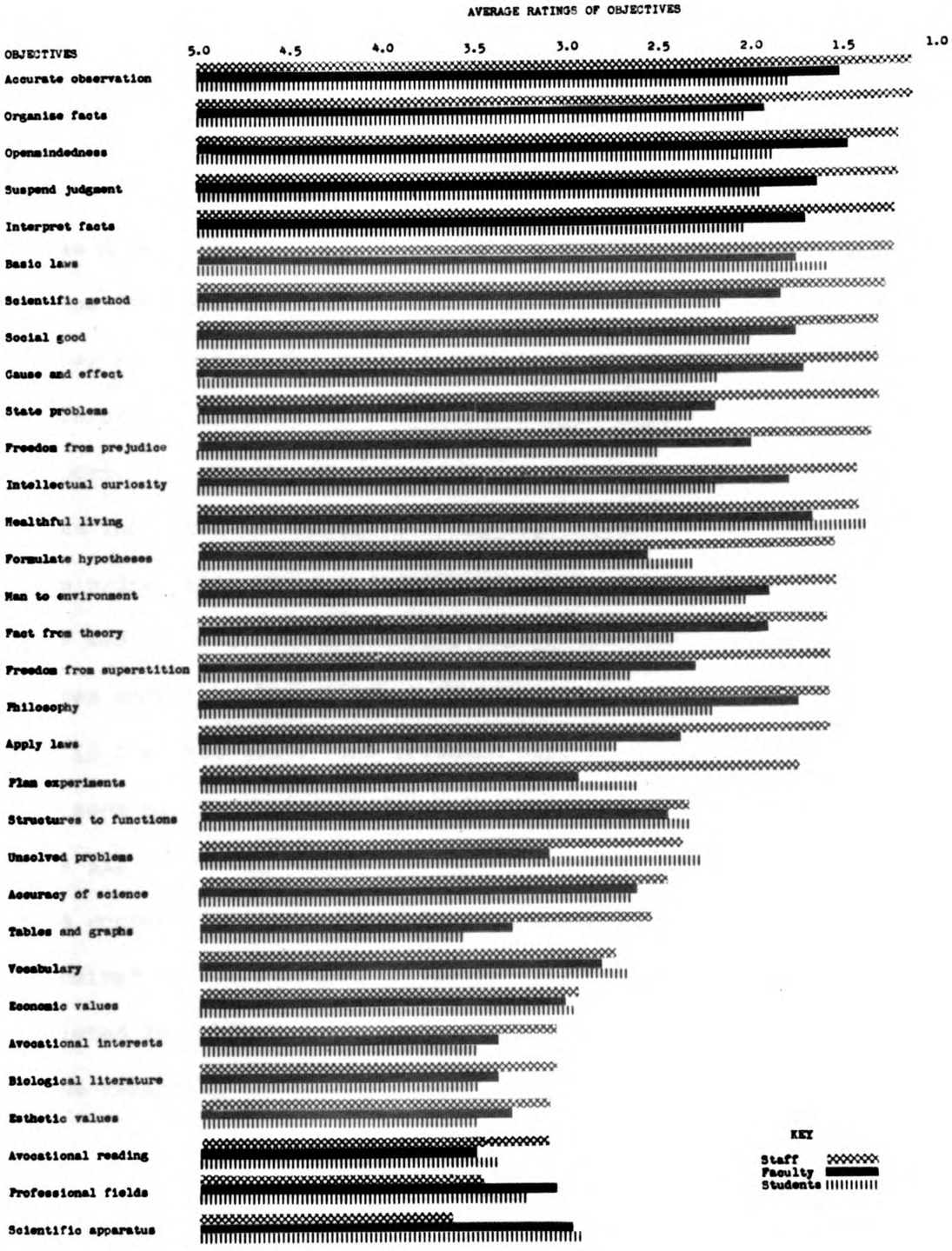
Figure 2 is a graphic representation of the data presented in Table VIII. In this figure the objectives are presented in order of their importance to the staff group. Since the lower numbers indicate a higher rating, the lower averages are on the right hand side of the Figure.

Of the ten objectives ranked highest by the students (Table IX, Figure 2) three were knowledge objectives, one was accurate observation, two were scientific attitudes, three were scientific method objectives, one was an objective which had been classified as an understanding. As has been pointed out previously the outstanding difference between the student groups and the staff group was the placement of the objective related to the knowledge of facts which should lead to more healthful living. All of the student groups ranked this as the most important objective, whereas it was $12\frac{1}{2}$ on the staff ranking. Of the faculty rankings it was in fourth place.

Several interesting facts are brought out in Table VIII. The group

FIGURE 2

AVERAGES OF RATINGS OF OBJECTIVES BY STAFF, FACULTY, AND STUDENTS IN ORDER OF IMPORTANCE OF THE OBJECTIVES TO THE STAFF


AVERAGE RATINGS OF OBJECTIVES
OBJECTIVES
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Accurate observation
Organise facts
Openmindedness
Suspend judgment
Interpret facts
Basic laws
Scientific method
Social good
Cause and effect
State problems
Freedom from prejudice
Intellectual curiosity
Healthful living
Formulate hypotheses
Man to environment
Fact from theory
Freedom from superstition
Philosophy
Apply laws
Plan experiments
Structures to functions
Unsolved problems
Accuracy of science
Tables and graphs
Vocabulary
Economic values
Avocational interests
Biological literature
Esthetic values
Avocational reading
Professional fields
Scientific apparatus
KEY
Staff
Faculty
Students

of students who were beginning biology ranked the scientific attitudes such as openmindedness, suspend judgment, and freedom from superstition much lower than any of the other groups ranked them. The seniors (who incidentally did not hear anything about the scientific method when they took the course in biological science; it had not at that time been included as a major course objective) ranked most of the scientific method objectives lower than any of the other groups had ranked them. There may be another explanation for these facts; this group was principally women. Sex differences, however, will be discussed in detail in a later part of this report.

As indicated in Tables VIII and XI, the ten lowest ranking objectives are principally those objectives which have been classified as appreciations and interests. In general, all groups ranked the same type of objectives among the lowest ten. However, the ability to apply principles appears in the last ten of the freshmen student objectives, whereas the seniors seem to find this a moderately important objective as evidenced in Table IX.

A comparison of the highest ranking and lowest ranking objectives, as determined by the averages of the ratings, for the three major groups is tabulated in Table X. Although all five of the student groups were in agreement regarding the most important objective and the least important objective, the highest ranking and lowest ranking objectives are different in the three major groups; that is, the student groups, the faculty group, and the staff group.

TABLE X

COMPARISON OF HIGHEST AND LOWEST RANKING OBJECTIVE FOR THREE MAJOR GROUPS

Group	Highest	Lowest
Staff	To learn to make accurate observations	To learn to use scientific apparatus
Faculty	To develop an attitude of openmindedness	To acquire a background for avocational reading
Students (all groups)	To become familiar with facts which will contribute to more healthful living	To learn to read and construct tables and graphs

Comparison of staff ratings of objectives with findings of similar studies. As was pointed out in Chapter II, the outstanding committee reports on objectives of science teaching have stressed the importance of teaching the scientific method, the importance of teaching general concepts, and the social importance of science. An inspection of Figure 1 and Figure 2 indicates that the staff of the Department of Biological Science is in agreement with the objectives as formulated by the outstanding men in the field of science teaching; these objectives have all been rated high by the staff group.

In the report of the committee on secondary school science of the National Association for Research in Science Teaching,[1] as mentioned in the review of the literature, there is a section on objectives of science teaching. This group will be referred to in this portion of this report as the N.A.R.S.T. group. The results of this investigation were reported in terms of total numbers of responses for five ratings. The ratings used in the committee study were the same as those used in the present study; that is, a one denoted great importance, while a five indicated that the objective was unimportant to the person responding to the rating sheet. However, in the N.A.R.S.T. study an X was used to denote complete disagreement with the statement, a Y was used to indicate that the respondee did not understand the meaning of the statement. Percentages were not calculated because in many parts of the report (which dealt with several other phases of teaching other than objectives) there were many who had

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[1] "Report of Committee on Secondary School Science of the National Association for Research in Science Teaching," op. cit., p. 226-227.

responded to the statement with an X, and the committee felt that they could not give proper weightings to these responses.

Many of the objectives presented to the specialists for rating were so similar to the objectives included in the rating sheet presented to the seven groups in the present study that it seemed that a comparison of the ratings of the specialist in science teaching to the ratings of the staff of the Department of Biological Science should be of interest. In order to make these comparisons it was necessary to calculate the percentages of the responses to the various objectives. Since there were very few ratings of "X" or "Y" for the objectives which seemed to compare to the objectives of the present study, the objections of the committee to treating the data in other terms than total numbers should be obviated.

In order to construct a table to show the comparison of the objectives of the two groups it seemed necessary to abbreviate the objectives as they were stated in the study of the N.A.R.S.T. The objectives which are to be used for comparison are presented here as they were stated, the abbreviation to be used in the comparative table (Table XI) follows each objective in parenthesis.

The following are some of the objectives of Secondary School science as presented in the study of the N.A.R.S.T.:[2]

> An objective of secondary school science shall be the mastery of those knowledges which are functional in aiding the individual to adjust himself in a more satisfying manner to the world about him. (functional knowledge)

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[2] Loc. cit.

An objective of secondary school science shall be to impart certain abilities to the student such as:

Reliance on facts. (reliance on facts)
Power of interpretation. (interpretation)
Power of observation. (observation)
Ability to evaluate data. (evaluation of data)
Ability to think scientifically. (scientific thinking)

An objective of secondary school science shall be to develop certain scientific attitudes or traits in the learner such as:

An objective attitude toward facts. (objectivity)
A freedom from dogma and prejudice. (freedom from dogma and prejudice)
Tendency to hold conclusions as tentative and to suspend judgment until facts are secured. (suspend judgment)
Willingness to revise one's opinions if the evidence warrants. (revise opinions)
To have a spirit of inquiry. (spirit of inquiry)
A conviction of the universality of cause and effect relationships. (cause and effect)

An objective of secondary school science shall be to develop appreciations for such as the following:

The contributions of the scientific mind. (contributions)
Nature. (appreciation of nature)

An objective of secondary school science shall be to develop in pupils:

An interest or desire for scientific reading. (scientific reading)
An interest in vocational fields. (vocational fields)

In certain instances a single objective of the N.A.R.S.T. group has been broken down into several objectives as presented in the present study and visa versa. In the table comparing the ratings of the objectives of the N.A.R.S.T. group with the ratings of the staff of biological science (Table XI), only those ratings denoting great importance, considerable importance, and average importance have been included. The other ratings were omitted to permit easier comparison of the ratings on which the following discussion was based. The complete data for the staff group are available in Tables I-VII, the complete data for the N.A.R.S.T.

TABLE XI

COMPARISON OF RATINGS OF OBJECTIVES
BY STAFF GROUP WITH RATINGS OF SIMILAR OBJECTIVES
BY MEMBERS OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Objectives	Ratings					
	1		2		3	
	N	%	N	%	N	%
Functional knowledge (NARST)	54	65.4	17	26.8	2	2.6
Healthful living (staff)	17	65.4	7	26.8	2	7.7
Social good (staff)	20	77.0	4	15.3	2	7.7
Reliance on facts (NARST)	48	61.5	17	21.8	3	3.9
Fact from theory (staff)	17	65.4	4	15.4	4	15.4
Interpretation (NARST)	48	62.3	13	16.9	8	10.3
Interpret facts (staff)	21	80.0	4	15.4	1	3.8
Observation (NARST)	47	61.8	14	18.4	6	7.9
Accurate observations (staff)	23	88.5	3	11.5	0	-
Evaluate data (NARST)	50	65.8	13	17.1	8	10.5
Interpret data (staff)	21	80.8	4	15.4	1	3.8
Scientific thinking (NARST)	60	80.0	8	10.7	1	1.3
Objectivity (NARST)	60	80.0	8	10.7	2	2.7
Revise opinions (NARST)	64	83.1	7	9.1	1	1.3
Openmindedness (staff)	23	88.5	2	7.7	0	-
Freedom from dogma and prejudice (NARST)	61	79.2	8	10.4	2	2.6
Freedom from superstition (staff)	15	57.7	8	30.8	2	7.7
Freedom from prejudice (staff)	20	77.0	5	19.2	0	-

TABLE XI (continued)

Objectives	Ratings					
	1		2		3	
	N	%	N	%	N	%
Suspend judgment (NARST)	63	80.0	7	9.0	4	5.1
Suspend judgment (staff)	22	84.6	3	11.6	1	3.8
Spirit of inquiry (NARST)	64	77.1	11	13.3	3	3.9
Intellectual curiosity (staff)	17	65.5	7	26.8	2	7.7
Cause and effect (NARST)	55	69.6	10	12.7	4	5.1
Cause and effect (staff)	20	76.9	4	15.4	2	7.7
Contributions (NARST)	30	39.5	26	34.2	12	15.8
Accuracy of science	9	34.6	3	11.5	9	34.6
Appreciation of nature (NARST)	33	45.2	14	19.2	11	15.1
Esthetic values (staff)	1	3.8	5	19.2	13	50.0
Scientific reading (NARST)	26	32.9	30	38.0	15	19.0
Biological literature (staff)	5	19.2	1	3.8	9	34.6
Vocational fields (NARST)	11	14.4	25	32.9	25	32.9
Vocational fields (staff)	1	3.8	5	19.2	7	26.9

group are available in the "Report of the Committee on Secondary School Science of the National Association for Research in Science Teaching."[3] In all cases the National Association for Research in Science Teaching objectives precede the objectives as stated in the present study.

That there is considerable agreement on the importance of the objectives which were common to both studies is evident from an inspection of Table XI. The present differences in the ratings of the two groups are in the objectives which have been classified as interests and appreciations. The National Association for Research in Science Teaching group considered that these objectives were of considerable importance compared to their importance as rated by the staff of biological science.

One objective is included in the list presented to the members of the National Association for Research in Science Teaching which was not included in the present study; the ability to think scientifically. It was assumed by the writer that the inclusion of the steps in scientific thinking would suffice. After the presentation of the rating sheet and analysis of the results it would appear that it would have been advisable to include this as an additional objective since the objective is rated higher by the N.A.R.S.T. group than any of the individual steps of the scientific method. One might infer that had this objective been included it would have been rated higher than any of the individual steps of the method by almost all of the groups.

The important aims of the staff of the Department of Biological

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[3] Loc. cit.

Science seem to be consistent with the opinion of the experts in science teaching regarding the aims of instruction. The students, however, consider that the important objectives are those of subject matter as was also found by Noll[4] to be true of many educators in his investigation of stated objectives in text books, courses of study, etc. It will be recalled that he found that 51.5 per cent of the objectives listed in these sources were subject matter objectives. It will also be recalled that the study of Hunter and Spore[5] showed that there had been a change in the objective which teachers were teaching for during the ten years between Hunter's first paper on objectives and the one of Hunter and Spore. The later study showed that the teachers were more concerned with objectives other than pure subject matter than they had been ten years earlier. It is encouraging that the teachers have changed. If they have changed there may be hope that with good instruction and proper motivation, the attitude of students toward non-subject matter objectives will also change.

Summary

1. Almost all objectives were rated as being considerably more important to the members of the staff of biological science than to the faculty as a whole or to the students.

2. In most instances the faculty ratings are intermediate between the ratings of the staff of biological science and the student groups.

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[4] Noll, op. cit., p. 8.

[5] Hunter and Spore, op. cit., p. 639.

3. The student groups were very similar in their ratings of most of the objectives.

4. The ratings of all of the groups were most similar on the objectives which have been classified as knowledge objectives, interests, and appreciations.

5. The greatest diversity of responses were among those objectives which have been classified as problem solving skills and attitudes.

6. There was a greater range in response to the objectives by the staff group than by any other group. In general, the staff of biological science considered the objectives to be of very considerable importance, or of very little importance.

7. Knowledge objectives, excepting the objective to acquire a vocabulary of useful biological terms, were rated fairly high by all groups.

8. Understanding objectives were, in general, rated lower than the knowledge objectives.

9. The ability to make accurate observations was rated high by all of the groups.

10. Other instrumental skills were rated low by all groups.

11. Scientific method objectives were all rated very high by the members of the Department of Biological Science, moderately high by the faculty, and most of the student groups. The seniors were an exception.

12. The scientific attitudes were all rated as major objectives by the staff group. Several of these were rated relatively high by the other groups.

13. Those objectives which have been classified as interest objectives and as appreciation objectives were considered by all groups to be less important than the other types of objectives.

14. Some of the objectives presented in this study were very similar to objectives presented in a study made by the National Association for Research in Science Teaching. The ratings of these objectives which were similar in the two studies were compared. The ratings of the two groups were similar in regard to the knowledge objectives, scientific method skills, and attitudes. Interest objectives and attitude objectives were rated as being considerably more important by the National Association for Research in Science Teaching group than by the members of the Department of Biological Science.

CHAPTER V

COMPARISON OF SPECIAL PERMISSION STUDENTS WITH REGULAR STUDENTS, MALES WITH FEMALES, AND YOUNGER MEN WITH OLDER MEN

Although the student groups were, in general, very similar in their ratings of the objectives, there were some differences in responses between the groups. It was thought that difference in the various student groups might be related to the composition of the groups. The senior group was predominately female in composition; the groups enrolled in the course in biology at the time of the study were principally male. The students who had not yet taken the course were a rather normal group in sex makeup; about one third of the students were women. It seemed logical to suppose that some of the differences between the student groups might be explained by differences in the sex makeup of the groups. For example, it was noted that the seniors considered the problem solving skills less urgent than the other student groups considered them to be. Sex differences in responses cause this difference.

Another factor which might have caused slight differences in the student groups was age. Since the age ranges of the groups varied somewhat, it was deemed advisable to determine whether responses to the objectives varied with age. The faculty group was, of course, older than the student group, so perhaps some of the differences between student and faculty opinions might be explainable on the basis of age differences.

The responses of the three groups enrolled in the course might be different because the students who show proficiency in biological science

are allowed to take the comprehensive early if they wish to do so. This group of students will be referred to in this chapter as the "special permission" group.

The differences considered in this chapter are, in general, not statistically significant. The values of "t" were found to be less than two standard errors, showing that there was more than one chance in twenty that these differences were due to fluctuations in random sampling. However, in response to some objectives there are certain trends which are consistent in the two or more groups discussed. Although the reliability of the differences are not significant, the statistical reliability may be of less importance in a study of this type than the trends they reveal. Such trends are reported in this chapter and inferences are based upon them.

Comparison of Special Permission Students with Regular Students. At the outset of this investigation it was supposed that there would probably be considerable difference between the responses of those students who took the comprehensive examination early, that is, the special permission students, and the students who did not take the comprehensive examination early. In other words, the writer had expected considerable difference between the good students and the average students. However, there was no outstanding difference in the ratings of the objectives by these two groups. In only a few instances were there any noticeable differences between them.

In the tables for this chapter the "X" ratings have been omitted to permit easier interpretation of the tables. As can be seen in Table

XVIII of the appendix, the special permission students considered knowledge of the basic laws of biology and knowledge which would contribute to more healthful living to be somewhat more important objectives than the regular students.

Of the objectives classified as understandings the only one in which a difference between the special permission students and the others appeared was the understanding of the relation of man to his environment, (Table XIX appendix). The data presented in Table XX of the appendix indicate that the superior students considered the ability to learn to use scientific instruments was a less important objective than the average group considered it to be. The evidence indicates that there is no differences in the responses of the groups to the objectives related to the scientific method skills, (Table XXI, appendix).

Of the scientific attitudes the only one showing a difference of response, as indicated in Table XXII of the appendix, is to the objective; to develop intellectual curiosity. The average students seem to consider this a slightly more important objective than the good students.

It might be supposed that some of the students did not understand the meaning of some of the objectives and that this might account for differences in the ratings of the objectives by these two groups. This does not seem likely since the respondents were instructed to mark any objective which they did not understand with an "X". There were very few so marked.

Table XXIII of the appendix gives evidence that the two groups did not differ in their opinions about the importance of the objectives

which have been classified as interest objectives.

The most interesting of the comparisons of these groups is in relation to the responses to the appreciation objectives. As may be seen in Table XXIV of the appendix, the average students seemed to feel that appreciation of the esthetic values of nature, an appreciation of current biological problems and an appreciation of the hard work, efforts, and accuracy necessary for any scientific investigation were somewhat more important than the better students considered them to be.

It is of interest that only in some of the knowledge and understandings objectives were the ratings by the special permission students higher than by the regular students. Of five objectives which were rated higher by the average students, three were appreciation objectives, one was to develop intellectual curiosity, and the other was to learn to use scientific apparatus. Whether these differences are due to the fact that the better students are more interested in knowledge and understandings, or whether the differences are due to the fact that most examinations test these objectives to a greater extent than they test other objectives of a course, and these students taking the comprehensive were more aware of the closeness of that examination, and more interested in the grade made on it, is difficult to say. Since the differences were rather small and only trends were evident, the differences may have been due to chance.

It will be recalled that ratings of the third term group were lower on most of the objectives than were the ratings by the other two groups of students who were taking the course in biological science. It was suggested in Chapter IV that these differences might be due to the fact that

many of the better students had already taken the comprehensive examination. This hypothesis is not substantiated by the data presented here. There is no evidence to indicate that the objectives which the superior students think are important are markedly different from the objectives which the average students consider important.

Sex and age differences. The data on sex and age are presented together because in all cases the age distribution of the women students was very narrow. Almost all of the women taking the course were in the 16 through 19 year age group. The senior women were all in the 20 through 23 year age group. The age differences were determined, therefore, only for the male population. Three age groups have been included in the analysis of the data; namely, 16 through 19, 20 through 23, and 24 and over. The latter group includes students up to the age of 37, but it was impossible to divide the latter group further because of the small numbers in the groups.

In certain groups the number of one sex or the other is quite small. There were only 19 women in the first term group and only 12 men in the senior group. Certain trends, however, were evident when the males of all of the groups were compared to the females of all of the groups. In the tables presented in this chapter the persons who did not rate the objective and those who did not know what the objective meant have been omitted to permit easier comparisons of the groups. Tables which show no major difference between sexes or between age groups have been placed in the appendix.

Table XII is interesting because all of the knowledge objectives

TABLE XII

COMPARISON OF RATINGS OF KNOWLEDGE OBJECTIVES
BY MEN AND WOMEN STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Vocabulary										
Pre men	26	13.0	45	22.5	68	34.0	32	16.0	28	14.0
women	14	14.2	27	27.5	31	31.6	18	18.3	8	8.1
121 men	16	12.1	33	25.0	55	41.6	14	10.6	13	9.8
women	2	10.5	7	36.8	7	36.8	3	15.7	0	-
122 men	34	12.2	64	23.1	110	39.7	50	18.0	18	6.4
women	4	11.4	9	25.7	10	28.5	7	20.0	5	14.2
Senior men	1	8.0	4	33.3	5	41.6	0	-	2	16.6
women	12	16.9	19	26.7	32	45.0	7	9.8	1	1.4
Basic laws										
Pre men	102	51.0	64	32.0	23	11.5	8	4.0	3	1.5
women	45	45.9	34	34.6	17	17.3	2	2.0	0	-
121 men	78	59.8	35	25.7	14	10.6	4	3.0	1	0.7
women	9	47.3	7	36.8	2	10.5	1	5.2	0	-
122 men	154	55.5	78	28.1	36	12.9	2	0.7	6	2.1
women	20	57.1	7	20.0	4	11.4	2	5.9	1	2.8
Senior men	9	75.0	2	16.6	1	8.3	0	-	0	-
women	39	54.9	25	35.2	7	9.8	0	-	0	-
Healthful living										
Pre men	119	59.5	54	27.0	21	10.5	4	2.0	2	1.0
women	67	68.3	21	21.4	6	6.1	3	3.0	1	1.0
121 men	83	62.8	32	24.2	13	9.8	2	1.5	2	1.5
women	17	89.5	1	5.2	1	5.2	0	-	0	-
122 men	196	70.7	45	16.2	26	9.3	6	2.1	3	1.0
women	25	71.4	6	17.1	3	8.5	1	2.8	0	-
Senior men	7	58.3	1	8.3	2	16.6	2	16.6	0	-
women	58	74.8	11	15.4	6	8.4	1	1.4	0	-
Social good										
Pre men	71	35.5	73	36.5	41	20.5	9	4.5	6	3.0
women	47	47.9	30	30.6	15	15.3	3	3.0	3	3.0
121 men	43	32.5	39	29.5	37	28.0	4	3.0	8	6.0
women	15	78.9	4	21.1	0	-	0	-	0	-
122 men	116	41.8	79	28.5	65	23.4	11	3.9	5	1.8
women	16	45.7	10	28.5	5	14.2	4	11.4	0	-
Senior men	5	41.6	2	16.6	3	25.0	1	8.3	1	8.3
women	25	36.6	28	39.4	12	16.9	4	5.6	1	1.4
Philosophy										
Pre men	61	30.5	61	30.5	50	25.0	12	6.0	12	6.0
women	37	37.7	24	24.4	21	21.4	11	11.2	3	3.0
121 men	41	31.0	38	28.7	31	23.4	11	8.3	9	6.7
women	8	42.1	4	21.0	4	21.0	3	15.7	0	-
122 men	89	32.1	86	31.0	65	23.4	21	7.5	12	4.3
women	12	34.2	9	25.7	10	28.5	2	5.7	2	5.7
Senior men	3	25.0	4	33.3	4	33.3	1	8.3	0	-
women	32	45.0	19	26.7	14	19.7	3	4.2	2	2.8

* Total number in group; Pre men - 200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

which relate to specific information, such as information which would lead to more healthful living, social good, and a more adequate philosophy of life, are rated as being considerably more important by the women students than by the men students. On the other hand, a knowledge of the laws of biology is, in general, considered to be a somewhat more important objective by the men than by the women. The sex differences, however, are not as marked in regard to this objective as they are in response to the objective related to healthful living and social good.

An inspection of Table XIII reveals that the knowledge of the laws of biology becomes increasingly important with age of the male students with the exception of the 121 group. Therefore, what appears to be a sex difference may be partially explained by a difference in the age composition of the groups. However, a comparison of the youngest age groups of the men (Table XIII) with the women as presented in Table XII shows that there is, apparently, a slightly higher rating of this objective by the males of each group than by the females.

With regard to the objectives on healthful living a similar situation is evident. As evidenced in Table XIII the younger men students rated this as a more important objective than the older students did. However, in most instances, the rating of the women, who, it will be recalled, were practically all in the youngest age bracket, were slightly higher than the men in the younger age group.

Of particular interest is the effect of age on the rating of the objective pertaining to social welfare. Here there is some evidence to

TABLE XIII

COMPARISON OF RATINGS OF KNOWLEDGE OBJECTIVES BY MEN OF THREE AGE GROUPS

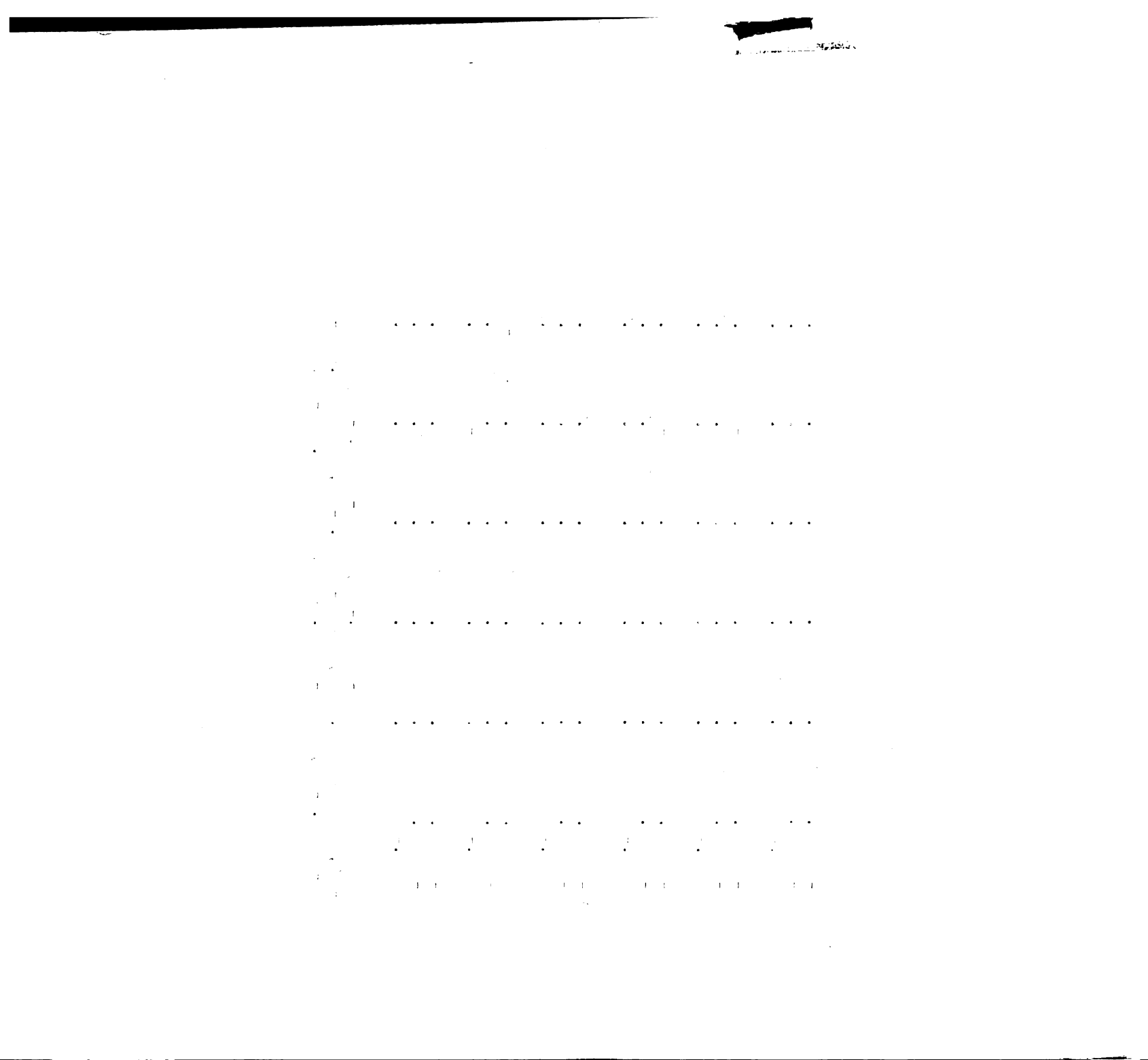
Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Vocabulary										
Pre 16-19 yrs.	11	14.8	17	22.9	23	31.0	13	17.5	10	13.5
20-23 yrs.	13	13.1	23	23.2	31	31.3	15	15.1	16	16.1
24 yrs-up	2	7.4	5	18.5	14	51.9	4	14.8	2	7.4
121 16-19 yrs.	2	7.1	8	28.6	16	57.1	0	-	2	7.1
20-23 yrs.	12	15.2	15	19.0	30	38.0	13	16.5	8	10.1
24 yrs.-up	2	8.0	10	40.0	9	36.0	1	4.0	3	12.0
122 16-19 yrs.	1	3.1	10	31.2	10	31.2	9	28.1	2	6.2
20-23 yrs.	23	12.3	44	23.1	80	43.0	26	13.9	13	6.9
24 yrs.-up	10	17.0	10	17.0	20	33.9	15	25.4	3	5.1
Basic laws										
Pre 16-19 yrs.	34	45.9	29	39.1	8	10.8	3	4.0	0	-
20-23 yrs.	52	52.5	29	29.2	11	11.1	4	4.0	3	3.0
24 yrs.-up	16	59.2	6	22.2	4	14.8	1	3.7	0	-
121 16-19 yrs.	19	67.9	6	21.4	2	7.1	1	3.6	0	-
20-23 yrs.	43	54.4	23	29.1	11	13.9	1	1.3	1	1.3
24 yrs.-up	16	64.0	6	24.0	1	4.0	2	8.0	0	-
122 16-19 yrs.	11	34.3	15	46.8	4	12.5	0	-	1	3.1
20-23 yrs.	104	55.9	52	27.9	24	12.9	2	1.0	4	2.1
24 yrs.-up	39	66.1	11	18.6	8	13.6	0	-	1	1.7
Healthful living										
Pre 16-19 yrs.	48	64.8	15	20.2	8	10.8	3	4.0	0	-
20-23 yrs.	54	54.5	33	33.3	10	10.1	1	1.0	1	1.0
24 yrs.-up	17	62.0	6	22.2	3	11.1	0	-	1	3.7
121 16-19 yrs.	19	67.9	6	21.4	2	7.1	0	-	1	3.6
20-23 yrs.	48	60.8	21	26.6	9	11.4	1	1.3	0	-
24 yrs.-up	16	64.0	5	20.0	2	8.0	1	4.0	1	4.0
122 16-19 yrs.	24	75.0	5	15.6	1	3.1	1	3.1	1	3.1
20-23 yrs.	131	70.4	32	17.2	18	9.6	4	2.1	1	0.6
24 yrs.-up	41	69.5	8	13.6	7	11.9	1	1.7	1	1.7

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XIII (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Social good										
Pre 16-19 yrs.	31	41.8	23	31.0	15	20.2	2	2.7	3	4.0
20-23 yrs.	32	32.3	38	38.3	21	21.2	6	6.0	2	2.0
24 yrs.-up	8	29.6	12	44.4	5	18.5	1	3.7	1	3.7
121 16-19 yrs.	7	25.0	10	35.7	9	32.1	0	-	2	7.1
20-23 yrs.	27	34.2	21	26.6	23	29.1	3	3.8	4	5.1
24 yrs.-up	9	36.0	8	32.0	5	20.0	1	4.0	2	8.0
122 16-19 yrs.	14	40.6	8	25.0	9	28.1	0	-	1	3.1
20-23 yrs.	73	39.2	58	31.1	44	23.1	7	3.7	3	1.6
24 yrs.-up	29	49.2	13	22.0	12	20.3	4	6.8	1	1.7
Philosophy										
Pre 16-19 yrs.	23	31.0	24	32.4	15	20.2	5	6.7	6	8.1
20-23 yrs.	32	32.3	30	30.2	28	28.2	6	6.0	3	3.0
24 yrs.-up	6	22.3	7	25.9	7	25.9	1	3.7	3	11.1
121 16-19 yrs.	11	39.3	8	28.6	7	25.0	2	7.1	0	-
20-23 yrs.	22	27.9	22	27.9	18	22.8	9	11.4	7	8.9
24 yrs.-up	8	32.0	8	32.0	6	24.0	0	-	2	8.0
122 16-19 yrs.	10	31.2	10	31.2	7	21.8	3	9.3	2	6.2
20-23 yrs.	55	29.5	58	31.1	48	25.8	14	7.5	9	4.8
24 yrs.-up	24	40.7	18	30.5	10	17.0	4	6.8	1	1.7

* Total number in group; Pre 16-19 yrs.- 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.



indicate that the objective is considered to be more important by the older men students. As can be seen in Table XIII, the trend is not highly significant. In all of the oldest groups, that is, in those over 24, the per cent who consider this to be a very important objective, or a quite important objective, is higher than the percentages of the younger groups. However, the older men do not consider this to be as important an objective as the women, who are almost all between the ages of 16 and 19. Are the women more socially conscious than the men? Or is social consciousness a matter of maturity? Do the women, who mature more rapidly than the men, reach a sense of social consciousness at an earlier age?

Although on an a priori basis one might expect the objective relative to a philosophy of life to receive higher ratings by the more mature students, the data as presented in Table XIII do not support such a thesis. There seems to be no age difference in response to this objective.

As was pointed out in Chapter IV, the seniors considered most of the knowledge objectives to be more important than the other student groups considered them. It will be recalled that this group was made up principally of women and that they were somewhat older than the women of the other student groups. The data on sex differences and age differences in regard to these objectives leads one to believe that these factors, at least, partially explain why the seniors considered these objectives of more importance than the other student groups.

Of the objectives which have been classified as understandings there appear to be no significant or consistent sex differences, as

indicated in Table XXV of the appendix. There are, however, marked age differences in the ratings on the objective to understand the relation of man to his environment (Table XIV). Older men in all groups considered this to be a more important objective than the younger men considered it to be. This is of particular interest because the literature shows a decline in emphasis on this phase of biology through the grades. That this objective becomes more important with age is substantiated by the fact that the percentage of seniors who considered this a very important objective was higher than the percentage of any of the other student groups considering this a very important objective and by the fact that the faculty group rated this objective as being more important than any of the student groups rated it. The meager evidence presented here might indicate that this objective becomes more meaningful as the student matures.

Another of the understandings objectives which shows an age trend is the ability to distinguish a fact from a theory. Again the more mature students give evidence of considering this to be more important than the less mature students as indicated in Table XIV. This is also evidenced by the ratings of the seniors and faculty, (Table II, Chapter IV).

Those objectives which have been classified as skills show no sex nor age differences, a fact brought out by Tables XXVI and XXVIII of the appendix.

Probably the most interesting of the comparisons of the sexes are the responses to the scientific method objectives. The men students feel

TABLE XIV

COMPARISON OF RATINGS OF UNDERSTANDING OBJECTIVES
BY MEN OF THREE AGE GROUPS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Man to environment										
Pre 16-19 yrs.	17	22.9	24	32.4	23	31.0	6	8.1	4	5.4
20-23 yrs.	29	29.2	41	41.4	23	23.2	2	2.0	3	3.0
24 yrs.-up	12	44.4	8	29.6	5	18.5	1	3.7	1	3.7
121 16-19 yrs.	5	17.9	13	46.4	10	35.7	0	-	0	-
20-23 yrs.	27	34.2	29	36.7	16	20.3	4	5.1	3	3.8
24 yrs.-up	12	48.0	5	20.0	5	20.0	2	8.0	1	4.0
122 16-19 yrs.	9	28.1	12	37.5	8	25.0	2	6.2	0	-
20-23 yrs.	67	36.0	63	33.8	39	20.9	8	4.3	8	4.3
24 yrs.-up	24	40.7	19	32.2	16	27.1	0	-	0	-
Structures to functions										
Pre 16-19 yrs.	6	8.1	33	44.5	23	31.0	9	12.1	3	4.0
20-23 yrs.	27	27.2	19	19.1	30	30.3	16	16.1	2	2.0
24 yrs.-up	4	14.8	9	33.3	9	33.3	2	7.4	2	7.4
121 16-19 yrs.	6	21.4	8	28.6	9	32.1	3	10.7	1	3.6
20-23 yrs.	18	22.8	31	39.2	16	20.3	7	8.9	6	7.6
24 yrs.-up	7	28.0	9	36.0	6	24.0	2	8.0	1	4.0
122 16-19 yrs.	12	37.5	10	31.2	5	15.6	4	12.5	0	-
20-23 yrs.	59	31.7	59	31.7	49	26.3	8	4.3	8	4.3
24 yrs.-up	17	28.8	22	37.8	15	25.4	2	3.3	1	1.7

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs. -up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XIV (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Apply laws										
Pre 16-19 yrs.	9	12.1	15	20.2	28	37.8	16	21.6	5	6.7
20-23 yrs.	20	20.2	15	15.1	36	36.3	17	17.1	11	11.1
24 yrs.-up	3	11.1	11	40.9	2	7.4	10	37.0	1	3.7
121 16-19 yrs.	5	17.9	13	46.4	4	14.3	4	14.3	1	3.6
20-23 yrs.	12	15.2	17	21.5	27	34.2	9	11.4	13	16.5
24 yrs.-up	6	24.0	6	24.0	7	28.0	3	12.0	3	12.0
122 16-19 yrs.	3	9.3	11	34.3	8	25.0	6	18.7	4	12.5
20-23 yrs.	36	19.3	44	23.1	57	30.6	21	11.2	25	13.4
24 yrs.-up	11	18.6	21	35.6	11	18.6	12	20.3	2	3.3
Fact from theory										
Pre 16-19 yrs.	16	21.6	24	32.4	16	21.6	15	20.2	1	1.3
20-23 yrs.	27	27.2	31	31.3	25	25.2	11	11.1	5	5.0
24 yrs.-up	10	37.0	11	40.7	4	14.8	1	3.7	1	3.7
121 16-19 yrs.	3	10.7	11	39.3	9	32.1	2	7.1	3	10.7
20-23 yrs.	17	21.5	27	34.2	20	25.3	11	13.9	4	5.1
24 yrs.-up	10	40.0	7	28.0	3	12.0	2	8.0	3	12.0
122 16-19 yrs.	7	21.8	3	9.3	15	46.8	4	12.5	2	6.2
20-23 yrs.	40	21.5	68	36.5	44	23.1	25	13.4	7	3.7
24 yrs.-up	15	25.4	21	35.6	15	25.4	4	6.8	4	6.8

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

that the ability to detect and state a problem, the ability to formulate hypotheses, the ability to plan experiments to test hypotheses, and the ability to organize facts are considerably more important objectives of biology than the women students consider them to be, (Table XV). There is, however, no evident sex difference in the ratings of the objective to develop the ability to interpret facts. Whether the women feel that actual research is "man's work" or whether difference in temperaments causes the differences would be difficult to determine. It is extremely interesting to observe that the women consistently rate the ability to transfer the scientific method to everyday problems higher than the men rate this objective. It is difficult to account for the fact that while the women consistently rate the skills involved in the method low, they rate the ability to use them quite high. How can they learn to apply the scientific method if they are not willing to learn to detect the problem, to consider possible solutions to the problem, and to organize the data?

As mentioned in Chapter IV, the seniors considered mastery of most of the scientific method skills were quite unimportant objectives; they rated them lower than any of the other student groups rated them. Apparently this lower rating of these objectives by the seniors is explicable by the fact that nearly all of them were women. Like the women of all of the other groups, however, they considered the ability to transfer the scientific method to their own and social problems to be quite important. In fact, they rated this objective higher than any of the other student groups rated it. Age does not seem to affect the ratings on the scientific method skills, (Table XXVII, appendix).

TABLE XV

COMPARISON OF RATINGS OF PROBLEM SOLVING SKILLS OBJECTIVES BY MEN AND WOMEN STUDENTS

Objectives and	Ratings									
	1		2		3		4		5	
Groups*	N	%	N	%	N	%	N	%	N	%
State problems										
Pre men	51	25.5	52	26.0	49	24.5	24	12.0	19	9.5
women	18	18.3	23	23.4	31	31.6	12	12.2	14	14.2
121 men	42	31.8	41	31.0	25	18.9	12	9.0	11	8.3
women	4	21.0	9	47.3	5	26.3	1	5.2	0	-
122 men	91	32.8	65	23.4	59	21.2	36	12.9	25	9.0
women	10	28.5	6	17.1	8	22.8	7	20.0	4	11.3
Senior men	3	25.0	2	16.6	4	33.3	2	16.6	1	8.3
women	9	12.6	20	28.1	24	33.8	10	14.0	7	9.8
Formulate hypotheses										
Pre men	47	23.5	72	36.0	42	21.0	28	14.0	10	5.0
women	16	16.3	29	29.5	25	25.5	15	15.3	10	10.3
121 men	44	33.3	36	27.2	29	21.9	16	12.1	7	5.3
women	7	36.8	6	31.5	3	15.7	2	10.5	1	5.2
122 men	85	30.6	69	24.9	69	24.9	28	10.1	24	8.6
women	9	25.7	5	14.2	11	31.4	6	17.1	4	11.3
Senior men	2	16.6	5	41.6	4	33.3	1	8.1	0	-
women	8	11.2	18	25.3	23	32.3	14	19.7	7	9.8
Plan experiments										
Pre men	32	16.0	68	34.0	42	21.0	38	19.0	17	8.5
women	11	11.3	12	12.3	23	23.4	22	22.4	12	12.3
121 men	28	21.2	34	25.7	35	26.5	23	17.4	12	9.0
women	2	10.5	5	26.3	8	42.1	0	-	4	21.0
122 men	45	16.2	72	25.9	85	30.6	36	12.9	37	13.3
women	4	11.3	8	22.8	4	11.3	13	37.1	6	17.1
Senior men	0	-	6	50.0	3	25.0	6	50.0	0	-
women	6	8.4	14	19.7	22	30.9	14	19.7	15	21.0

* Total number in group; Pre men -200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XV (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Organize facts										
Pre men	79	39.5	65	32.5	39	19.5	10	5.0	6	3.0
women	29	29.5	34	34.6	26	26.5	5	5.1	4	4.0
121 men	52	39.3	47	35.6	20	15.1	6	4.5	7	5.3
women	2	10.5	11	57.8	4	21.0	2	10.5	0	-
122 men	99	35.7	94	33.9	57	20.5	14	5.0	13	4.6
women	10	28.5	9	25.7	10	28.5	5	14.2	1	2.8
Senior men	1	8.3	7	58.3	3	25.0	1	8.3	0	-
women	16	22.5	33	46.4	15	21.0	7	9.8	0	-
Interpret facts										
Pre men	81	40.5	68	34.0	39	19.5	8	4.0	4	2.0
women	36	36.7	35	35.6	17	17.3	7	7.1	3	3.0
121 men	49	37.1	46	34.7	21	15.9	12	9.0	4	3.0
women	8	42.1	7	36.8	3	15.3	1	5.2	0	-
122 men	100	36.1	92	33.2	56	20.2	17	6.1	11	3.9
women	13	37.1	9	25.7	8	22.8	3	8.3	2	5.7
Senior men	3	25.0	6	50.0	3	25.0	0	-	0	-
women	19	26.7	30	42.2	18	25.3	2	2.8	2	2.8
Scientific method										
Pre men	67	33.5	57	28.5	57	28.5	15	7.5	3	1.5
women	42	42.8	33	33.6	17	17.3	3	3.0	3	3.0
121 men	34	25.7	52	39.3	29	21.9	12	9.0	5	3.7
women	9	47.3	8	42.1	2	10.5	0	-	0	-
122 men	85	30.6	93	33.5	73	26.3	18	6.4	8	2.8
women	17	48.5	9	25.7	7	20.6	2	5.7	0	-
Senior men	4	33.3	6	50.0	0	-	1	8.3	1	8.3
women	26	36.6	25	36.6	12	16.9	6	8.4	2	2.8

* Total number in group; Pre men -200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

Whereas the method of science was not as important to the women as to the men, the attitudes which attend the scientific method were all of more importance to them than to the men as can be seen in Table XVI. In almost all of the groups the women gave evidence of believing that the ability to recognize true cause and effect relationships, to be openminded, to develop freedom from prejudice and from superstition, and a willingness to suspend judgment were somewhat more important objectives than the men considered them to be. It is of particular interest to note that the women rated intellectual curiosity considerably higher than the men rated it.

Although there were no evident age differences regarding the scientific method skills, there is evidence that the older students consider all of the scientific attitudes to be somewhat more important than the younger students consider them (Table XVII). This may explain why the group of students who had not had biology, that is the entering freshmen, rated the attitudes somewhat lower than the other students rated them. The average age of this group was lower than the average age of the other groups. As was the case in regard to sex differences relative to the scientific attitudes, intellectual curiosity showed the greatest difference in ratings. The older men considered this to be considerably more important than the younger men considered it. Again one wonders if this is related to differential maturation rates.

The only interest objective which showed an appreciable difference was the one related to the professional aspects of biology. The men in all groups considered that to become acquainted with the nature and extent

TABLE XVI

COMPARISON OF RATINGS OF ATTITUDE OBJECTIVES
BY MEN AND WOMEN STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Cause and effect										
Pre men	64	32.0	57	28.5	41	20.5	16	8.0	20	10.0
women	37	37.7	26	26.5	18	18.3	7	7.1	8	8.1
121 men	44	33.3	37	28.0	33	25.0	10	7.5	7	5.3
women	12	63.1	3	15.7	4	21.0	0	-	0	-
122 men	90	32.4	77	27.7	57	20.5	27	9.7	19	6.8
women	11	31.4	8	22.8	7	20.0	5	14.2	3	8.5
Senior men	4	33.3	3	25.0	3	25.0	2	16.6	0	-
women	26	36.6	22	30.9	16	22.5	3	4.2	4	5.6
Openmindedness										
Pre men	64	32.0	56	28.0	43	21.5	21	10.5	9	4.5
women	36	36.6	23	23.4	19	11.3	10	10.2	6	6.1
121 men	57	43.1	43	32.5	18	13.6	9	6.7	4	3.0
women	14	73.6	5	26.3	0	-	0	-	0	-
122 men	110	39.7	89	32.1	52	18.7	16	5.7	6	2.1
women	21	60.0	8	22.8	3	8.5	2	5.7	1	2.8
Senior men	4	33.3	5	41.6	2	16.6	1	8.3	0	-
women	29	40.8	24	33.8	13	18.3	1	1.4	2	2.8
Freedom from superstition										
Pre men	33	16.5	23	11.5	47	23.5	25	12.5	72	36.0
women	17	17.3	16	16.3	18	18.3	16	16.3	30	30.6
121 men	40	30.3	17	12.8	25	18.9	19	14.3	29	21.9
women	7	36.8	5	26.3	5	26.3	1	5.2	1	5.2
122 men	69	24.9	42	15.1	70	25.2	32	12.5	60	21.6
women	13	37.1	8	22.8	4	11.3	2	5.7	8	22.8
Senior men	1	8.3	0	-	4	33.0	4	33.0	3	25.0
women	19	26.7	15	21.1	14	19.7	8	11.2	15	21.1

* Total number in group;; Pre men -200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XVI (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Suspend judgment										
Pre men	51	25.5	76	38.0	48	24.0	16	8.0	8	4.0
women	32	32.5	26	26.5	29	29.5	10	10.2	0	-
121 men	49	37.1	46	34.7	25	18.9	8	6.0	4	3.0
women	12	63.1	4	21.0	3	15.7	0	-	0	-
122 men	94	33.9	96	34.6	67	24.1	11	3.9	7	2.5
women	9	25.7	11	31.4	9	25.7	4	11.3	2	5.7
Senior men	6	50.0	2	16.6	2	16.6	1	8.3	0	-
women	27	38.0	25	35.2	13	18.3	5	7.0	1	1.4
Freedom from prejudice										
Pre men	49	24.5	36	18.0	46	23.0	25	12.5	40	20.0
women	38	38.7	18	18.3	12	12.2	16	16.3	12	12.2
121 men	29	21.9	36	27.2	29	21.9	12	9.0	26	19.7
women	11	57.8	5	26.3	3	15.7	0	-	0	-
122 men	76	27.4	64	23.1	60	21.6	28	10.1	43	15.5
women	12	34.2	7	20.0	5	14.2	5	14.2	4	11.2
Senior men	3	25.0	4	33.3	1	8.3	0	-	4	33.3
women	21	29.5	18	25.3	13	18.3	9	12.6	9	12.6
Intellectual ouriosity										
Pre men	56	28.0	68	34.0	42	21.0	21	10.5	11	5.5
women	41	41.8	28	28.5	12	12.2	7	7.1	9	9.1
121 men	43	32.5	36	27.2	35	25.7	9	6.7	8	6.0
women	9	47.3	4	21.0	5	26.3	0	-	1	5.2
122 men	89	32.1	70	25.2	72	25.9	27	9.7	17	6.1
women	10	28.5	11	31.4	8	22.8	4	11.2	2	5.7
Senior men	1	8.3	2	16.6	5	41.6	2	16.6	1	8.3
women	31	43.6	18	25.3	13	18.3	4	5.6	4	5.6

* Total number in group; Pre men -200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XVII

COMPARISON OF RATINGS OF ATTITUDE OBJECTIVES
BY MEN OF THREE AGE GROUPS

Objectives and Groups*	Ratings 1		2		3		4		5	
	N	%	N	%	N	%	N	%	N	%
Cause and effect										
Pre 16-19 yrs.	18	24.3	18	24.3	19	25.6	6	8.1	11	14.8
20-23 yrs.	38	38.3	26	26.2	18	18.1	10	10.1	7	7.0
24 yrs.-up	8	29.6	13	48.1	4	14.8	0	-	2	7.4
121 16-19 yrs.	10	35.7	6	21.4	6	21.4	4	14.3	1	3.6
20-23 yrs.	21	26.6	27	34.2	21	26.6	6	7.6	4	14.3
24 yrs.-up	13	52.0	4	16.0	6	24.0	0	-	2	8.0
122 16-19 yrs.	11	34.4	9	28.1	5	15.6	2	6.2	3	9.3
20-23 yrs.	61	32.7	49	26.3	41	22.0	18	9.6	13	6.9
24 yrs.-up	18	30.5	19	32.2	11	18.6	7	11.9	3	5.1
Openmindedness										
Pre 16-19 yrs.	20	27.0	22	29.7	15	20.2	11	14.8	5	6.7
20-23 yrs.	35	35.3	23	23.2	24	24.2	9	9.0	4	4.0
24 yrs.-up	9	33.3	11	40.7	4	14.8	1	3.7	0	-
121 16-19 yrs.	13	46.4	10	35.7	1	3.6	3	10.7	1	3.6
20-23 yrs.	28	35.4	30	38.0	16	20.3	2	2.5	2	2.5
24 yrs.-up	16	64.0	3	12.0	1	4.0	4	12.0	1	4.0
122 16-19 yrs.	11	34.4	11	34.4	4	12.5	4	12.5	1	3.1
20-23 yrs.	75	40.3	59	31.7	39	20.9	8	4.3	4	2.1
24 yrs.-up	24	40.7	19	32.2	9	15.3	4	6.8	1	1.7
Freedom from superstition										
Pre 16-19 yrs.	8	12.8	10	13.5	17	22.9	12	16.2	27	36.4
20-23 yrs.	18	18.1	9	9.0	23	23.2	12	12.1	37	37.3
24 yrs.-up	7	25.9	4	14.8	7	25.9	1	3.7	8	29.6
121 16-19 yrs.	8	28.6	3	16.7	8	28.6	4	14.3	5	17.9
20-23 yrs.	18	22.8	10	12.7	16	20.3	14	17.7	19	24.1
24 yrs.-up	14	56.0	4	16.0	1	4.0	1	4.0	5	20.0
122 16-19 yrs.	6	18.7	2	6.2	9	28.1	7	21.8	8	25.0
20-23 yrs.	45	24.1	26	13.9	55	29.5	20	10.7	37	19.8
24 yrs.-up	18	30.5	14	23.7	6	10.2	5	8.5	15	25.4

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs.- 99; Pre 24 yrs. - up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XVII (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Suspend judgment										
Pre 16-19 yrs.	22	29.7	25	33.7	19	25.6	8	10.8	0	-
20-23 yrs.	24	24.2	35	35.3	24	24.2	8	8.0	7	7.0
24 yrs.-up	5	18.5	16	59.3	5	18.5	0	-	1	3.7
121 16-19 yrs.	12	42.9	7	25.0	6	21.4	3	10.7	0	-
20-23 yrs.	24	30.3	32	40.5	17	21.5	4	5.1	2	2.5
24 yrs.-up	12	48.0	7	28.0	2	8.0	1	4.0	2	8.0
122 16-19 yrs.	7	21.8	14	40.6	8	25.0	2	6.2	1	3.1
20-23 yrs.	63	33.8	65	34.9	43	23.1	7	3.7	6	3.2
24 yrs.-up	24	40.7	17	28.9	16	27.1	2	3.4	0	-
Freedom from prejudice										
Pre 16-19 yrs.	16	21.6	14	19.1	21	28.3	11	14.8	10	13.5
20-23 yrs.	25	25.2	16	16.1	17	17.1	13	13.1	27	27.2
24 yrs.-up	8	29.6	6	22.2	8	29.6	1	3.7	3	11.1
121 16-19 yrs.	7	25.0	7	25.0	6	21.4	3	10.7	5	17.9
20-23 yrs.	12	15.2	23	29.1	19	24.1	7	8.9	18	22.8
24 yrs.-up	10	40.0	6	24.0	4	16.0	2	8.0	3	12.0
122 16-19 yrs.	10	31.2	3	9.3	10	31.2	4	12.5	5	16.6
20-23 yrs.	45	24.1	46	24.7	42	22.5	17	9.1	30	16.1
24 yrs.-up	21	35.6	15	25.4	8	13.6	7	11.9	8	13.6
Intellectual curiosity										
Pre 16-19 yrs.	20	27.0	23	31.0	18	25.6	8	10.8	3	4.0
20-23 yrs.	27	27.2	35	35.3	18	18.1	11	11.1	8	8.0
24 yrs.-up	9	33.3	10	37.0	5	18.5	2	7.4	0	-
121 16-19 yrs.	10	35.7	6	21.4	10	35.7	2	7.1	0	-
20-23 yrs.	23	29.1	22	27.9	20	25.3	7	8.9	6	7.6
24 yrs.-up	10	40.0	8	32.0	5	20.0	0	-	2	8.0
122 16-19 yrs.	7	21.8	7	21.8	11	34.4	3	9.3	4	12.5
20-23 yrs.	54	29.0	48	25.8	49	26.3	20	10.7	13	6.9
24 yrs.-up	28	47.5	15	25.4	12	20.3	4	6.8	0	-

* Total number in group; Pre 16-19 yrs.-74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

of the professional fields of biology was considerably more important than the women students believed it to be, (Table XXIX, appendix). Because there are more men than women interested in the professional fields of biology one would expect that more men would consider this objective more important. There was no age difference in response to this objective nor were there age differences in response to the other interest objectives, (Table XXX, appendix).

As can be seen in Table XXXI and XXXII of the appendix there was only one of appreciation objectives which showed either sex or age differences. The male students were slightly more enthusiastic about the economic values of biology than were the women.

SUMMARY

1. Students taking the comprehensive examination early rated knowledge of laws of biology, knowledge of facts for healthful living and an understanding of the relation of man to his environment as slightly more important objectives than those students who were not taking the comprehensive early.

2. Students not taking the comprehensive early considered that to learn to use scientific apparatus, to develop intellectual curiosity, and the appreciation objectives were somewhat more important than the students who were taking the comprehensive examination considered them to be.

3. Difference between the responses of those who took the comprehensive and those who did not take the comprehensive examination were

not large. The two groups were surprisingly similar in their ratings on the objectives.

4. The women students considered that knowledge for healthful living, social good, and for a satisfactory philosophy of life were more important than the men considered them to be.

5. The men rated knowledge of the basic laws of biology higher than the women students rated this objective.

6. The younger men rated knowledges which would contribute toward healthful living higher, and knowledges of the basic laws of biology lower than the older men. Since the women were almost all in the younger age brackets, the sex differences evident for these two objectives were probably rather insignificant.

7. The older men considered that knowledges which would contribute toward social good to be more important than the younger men.

8. There were no evident differences between the sexes in their ratings of the understanding objectives, but the older men rated the objectives, to understand the relation of man to his environment, and to learn to distinguish a fact from a theory higher than the younger men.

9. In general, the men rated the scientific method skills higher than the women rated them, whereas the women rated the scientific attitudes higher than the men.

10. There were no age differences in response to the scientific method skills, but the older men rated the scientific attitude higher than the younger men rated them.

11. The men rated the professional aspects of biology and the economic values higher than the women rated them.

CHAPTER VI

SUMMARY AND CONCLUSIONS

SUMMARY

1. The purposes of this study were (1) to determine the instructional aims of those persons teaching biological science at Michigan State College; (2) to evaluate these aims in terms of the importance attached to them by a) the faculty at Michigan State College and b) the students at Michigan State College; and (3) to compare these objectives with the aims which other groups not at Michigan State College considered to be important.

2. The rating sheet of thirty-two objectives was derived from lists of objectives submitted by the members of the Department of Biological Science.

3. The rating sheet was presented to members of the Department of Biological Science, to a group of members of the faculty of Michigan State College teaching subjects other than biology, to a group of seniors who had taken biological science as freshmen, and to four groups of students enrolled in biological science at the time of this study.

4. The objectives were classified into the following categories; (1) knowledge, (2) understanding, (3) instrumental skills, (4) problem solving skills, (5) attitudes, (6) interests, and (7) appreciations.

5. The knowledge objectives, with the exception of the objective relative to a useful vocabulary, were all rated as being important by

all of the groups. A vocabulary of useful biological terms was considered by all groups to be the least important of the knowledge objectives.

6. Understanding objectives were rated by all groups as less important than knowledge objectives.

7. The problem solving skills were rated as very important objectives by most of the members of the Department of Biological Science, whereas they were rated as moderately important objectives by all of the other groups.

8. All of the attitudes were considered to be very important objectives by most of the members of the Department of Biological Science, and moderately important objectives by all of the other groups.

9. The interest objectives and the appreciation objectives were rated low by all of the groups studied.

10. Differences between the ratings of the objectives by the group of students taking the comprehensive examination early and students taking the full three terms of the course were very small.

11. The women students considered that knowledge which would lead to more healthful living and knowledge which would lead to social good to be somewhat more important objectives than the men considered them to be.

12. The men students considered most of the scientific method skills to be more important than the women students considered them to be, whereas in the case of the scientific attitudes women considered them to be more important than the men did.

13. The older men considered that knowledge which would lead to social good and that the scientific attitudes were more important objectives of biology than did the younger men.

CONCLUSIONS AND EDUCATIONAL IMPLICATIONS

Because the conclusions and educational implications of this study are related to many phases of teaching, it is impossible to draw all of the conclusions together and interrelate them with all of the types of objectives studied. The conclusions will, therefore, be considered in relation to each type of objective.

Knowledge objectives. Regarding the knowledge objectives there was considerable agreement in all groups. The vocabulary objective was considered by all groups to be a relatively unimportant one. It has been the policy of the Department of Biological Science to limit the vocabulary, and in so far as possible to eliminate technical terms. This policy seems justified on the basis of this study.

The other knowledge objectives were considered to be quite important by most groups; the students believed that knowledge of facts which would contribute toward healthful living was the most important objective of biology. The staff group considered that knowledge of facts leading to social good was the most important of the knowledge objectives.

Certain teaching problems and problems for future research are suggested by these findings;

1. A further study on the number of terms used in the course, the number of terms which are functional, the number and kinds of terms the students know when entering the course, and the number of terms which are learned by the average student during the course seems advisable.

2. The comprehensive examination at the present time allows for eight per cent of the questions in the examination on vocabulary. Since,

in addition, the student must know the meanings of many terms to answer other questions, it would seem advisable to reduce the per cent of questions devoted to the knowledge of meaning of terms and to test only on terms demonstrated to be useful.

3. The students should be motivated to realize that knowledge in itself is not an objective of any science course, that knowledge is merely a prerequisite to the attainment of the true aims of the course.

Understanding objectives. In general these objectives were considered more important by the faculty groups than by the student groups. All groups considered that the understanding objectives were considerably less important than the knowledge objectives. Some of the problems which arise from these findings are:

1. The students must be motivated to realize that knowledge in itself is of little value; that knowledge to be functional must be understood, and related with other information and applied to new situations.

2. An inclusion in the comprehensive examination of more items which required the student to possess certain knowledge, but which also called for functional use of this knowledge might aid in the motivation of the student to appreciate the importance of functional understandings. At the present time knowledge and understanding are included in a single category as far as the construction of the test items for the comprehensive is concerned.

Instrumental skill objectives. Although the ability to observe accurately was considered to be an extremely important objective by the staff group, and quite important by the other groups, the other instrumental skill objectives were considered by all groups to be among the

least important of the objectives studied. One problem which is related to these observations is:

1. To devise ways to test accurate observations in an examination.

Problem solving skills. As indicated by the ratings of these objectives by the staff of biological science, the staff is teaching and thinking in terms of objectives other than subject-matter. All of the committees reporting on science in general education recommend that the scientific method be emphasized in the teaching of science. The students, however, considered these objectives to be only of moderate importance. Many problems arise from this situation:

1. Ways of motivating the students to accept these as important objectives should be found.

2. It has been suggested that the ability to use the scientific method is so closely related to intelligence that it cannot be taught. Experimentation on this phase of teaching is needed.

3. In order to determine whether the scientific method is teachable a test must be devised to test this ability adequately.

4. If the ability to use the scientific method is a native ability rather than an acquired one, should we abandon testing for ability to use it? May not the ability to memorize facts also be a native ability? No one suggests that we discontinue the practice of testing for information acquired by the student.

Attitude objectives. Like the objectives dealing with the scientific method the attitude objectives were considered very important by the staff of the Department of Biological Science and by other educators

in the field of science education, but were considered to be only moderately important by the students. Some problems arising from these findings are:

1. To devise methods to motivate the students to accept changes in attitudes as important course objectives.

2. To motivate the student to see the relation between the ability to use the scientific method, scientific attitudes, and his own personal success in solving his problems and in solving social problems.

3. In order to measure changes in attitudes, attitude tests or attitude scales must be devised. Is it possible to devise a paper and pencil test or attitude scale which will distinguish between the person who knows what his attitude should be and the person whose behavior is consistent with this knowledge?

4. Assuming that such tests or scales can be devised, can we give grades in a course based partially on the attitude of the student? The attitudes are frequently referred to as the intangibles of education, but if they are important objectives of a course they should be tested for and should enter into the evaluation of the student's achievements.

Interest objectives. Since all of the interest objectives were considered to be relatively unimportant by all groups, it would appear that these objectives should not be made major objectives of the course in biological science.

Appreciation objectives. The appreciation objectives were rated similarly to the interest objectives and should probably not be considered as major objectives of the course in biology at Michigan State College.

General conclusions and educational implications. In a general education program the objectives of a course should be functional and should be related to the needs of the students. There is evidence to indicate that the present expressed needs of the students are being met by the course and that certain future needs of the students have been considered in the formulation of the curriculum.

In this study objective data have been obtained which can serve as a basis for determining the relative number of items on the examination of the course to be devoted to the testing of the major objectives.

The principal educational problem presented by this study is one of determining methods of motivation.

It[1] has been said that until science teachers learn to think of the purposes of their work in terms of changes in behavior of their pupils, rather than in terms of facts, science will be taught as a body of organized knowledge. The present writer is in agreement with this viewpoint but would add that until students can be made aware of the purpose of education in terms of changes in their behavior, rather than in terms of facts, they will learn a body of organized knowledge in spite of the efforts of the teacher to bring about these desired changes.

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[1] Noll, op. cit., p. 11.

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APPENDIX

Letter to faculty members:

Faculty Member
Michigan State College

A study is being made of the objectives of the course in biological science. The enclosed rating sheet of objectives has been given to students taking biology, and to students who have completed the course in biological science. We are anxious to obtain ratings of the objectives from a group of faculty members.

Your cooperation in filling out this rating sheet will be of value to us in improving and revising the course.

Please mail the completed rating sheet to the Department of Biological Science, Basic College Building by January 20, 1948, if possible.

Thank you for your cooperation.

Very truly yours,

Mary Alice Burmester

Letter to seniors:

A study is being made of the objectives of the course in biological science. The enclosed rating sheet of objectives has been given to students taking biology. We are anxious to obtain ratings of the objectives from a group of students who have completed the course.

Your cooperation in filling out this rating sheet will be of value to us in improving and revising the course.

Please mail the completed rating sheet to the Department of Biological Science, Basic College Building by January 20, 1948, if possible.

Thank you for your cooperation.

Very truly yours,

Mary Alice Burmester

TABLE XVIII

COMPARISON OF RATINGS OF KNOWLEDGE OBJECTIVES
BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Vocabulary										
121 special	12	20.3	16	27.1	20	33.9	8	13.5	3	5.0
regular	28	10.5	78	29.3	103	38.7	34	12.7	21	7.8
122 special	8	8.1	22	22.4	44	44.9	19	19.3	5	5.1
regular	30	14.0	51	23.8	76	35.5	38	17.7	18	8.4
Basic laws										
121 special	39	66.1	17	28.8	3	5.0	0	-	0	-
regular	154	57.8	68	25.5	33	12.3	10	3.7	1	0.3
122 special	58	59.1	25	25.5	12	12.2	1	1.0	2	2.0
regular	116	54.2	60	28.0	28	13.0	3	1.4	5	2.3
Healthful living										
121 special	47	76.6	7	11.8	4	6.7	1	1.6	0	-
regular	198	74.4	43	16.1	18	6.7	3	1.1	4	1.5
122 special	76	77.5	11	11.2	9	9.1	1	1.0	1	1.0
regular	145	67.7	40	18.6	20	9.3	6	2.8	2	0.9
Social good										
121 special	30	50.8	16	27.1	6	10.1	4	6.7	2	3.3
regular	99	37.2	89	33.4	54	20.3	9	3.3	13	4.8
122 special	42	42.8	27	27.5	22	22.4	5	5.1	2	2.0
regular	90	42.0	62	28.9	48	22.4	10	4.6	3	1.4
Philosophy										
121 special	20	33.9	22	27.2	11	18.6	4	6.7	1	1.6
regular	80	30.0	78	29.7	63	23.6	23	8.6	16	6.0
122 special	26	26.5	26	26.5	28	28.6	9	9.2	8	8.2
regular	75	35.0	69	32.2	47	21.9	14	6.5	6	2.8

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XIX

COMPARISON OF RATINGS OF UNDERSTANDING OBJECTIVES BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Man to environment										
121 special	32	54.2	17	28.8	9	15.2	1	1.6	0	-
regular	83	31.2	99	37.2	61	22.9	13	4.8	10	3.7
122 special	39	39.8	34	34.6	17	17.3	3	3.0	4	4.0
regular	74	34.5	72	33.6	54	25.2	8	3.7	5	2.3
Structures to function										
121 special	17	28.8	25	42.3	12	20.3	4	6.7	0	-
regular	58	21.8	94	35.3	72	27.0	28	10.5	10	3.7
122 special	30	30.6	33	33.6	27	27.5	4	4.0	2	2.0
regular	70	32.7	66	30.8	50	23.3	15	7.0	8	3.7
Apply laws										
121 special	11	18.6	19	32.2	16	27.1	8	13.5	3	5.0
regular	46	17.2	62	23.3	84	31.5	38	14.3	33	12.3
122 special	13	13.2	28	28.5	27	27.5	20	20.4	9	9.1
regular	46	21.1	54	25.2	55	25.7	28	13.0	27	12.6
Fact from theory										
121 special	13	22.0	19	32.2	14	23.7	7	11.8	6	10.1
regular	68	25.5	82	30.8	76	28.5	25	9.4	15	5.6
122 special	20	20.4	30	30.6	30	30.6	15	15.3	3	3.0
regular	47	21.9	73	34.1	57	26.6	23	10.7	11	5.1

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XX

COMPARISON OF RATINGS OF INSTRUMENTAL SKILL OBJECTIVES BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Accurate observations										
121 special	25	42.3	23	38.9	7	11.8	1	1.6	3	5.0
regular	139	52.2	76	28.5	33	12.3	9	3.3	9	3.3
122 special	46	46.9	31	31.6	12	12.2	4	4.0	5	5.1
regular	93	43.4	71	33.1	35	16.3	9	4.2	6	2.8
Graphs and tables										
121 special	2	3.3	6	10.1	16	27.1	13	22.0	22	37.2
regular	14	5.2	26	9.7	91	34.2	54	20.3	81	30.4
122 special	6	6.1	15	15.3	20	20.4	27	27.5	30	30.6
regular	9	4.2	30	14.0	56	26.1	44	20.5	74	34.5
Scientific apparatus										
121 special	4	6.7	15	25.4	19	32.2	13	22.0	8	13.5
regular	36	13.5	65	24.4	84	31.5	48	18.0	33	12.3
122 special	7	7.1	16	16.3	38	38.7	26	26.5	11	11.2
regular	34	15.8	47	21.9	67	31.3	35	16.3	31	14.4

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XXI

COMPARISON OF RATINGS OF PROBLEM SOLVING SKILL OBJECTIVES BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
State problems										
121 special	16	27.1	20	33.9	10	16.9	9	15.2	4	6.7
regular	85	31.9	81	30.4	55	20.6	21	7.8	22	8.2
122 special	32	32.6	22	22.4	21	21.4	13	13.2	10	10.2
regular	69	32.2	49	22.8	46	21.1	30	14.0	19	8.8
Formulate hypotheses										
121 special	14	23.7	19	32.2	17	28.8	6	10.1	3	5.0
regular	88	33.0	72	27.0	59	22.1	33	12.3	14	5.2
122 special	30	30.6	24	24.4	26	26.5	9	9.1	9	9.1
regular	64	29.9	50	23.3	54	25.2	25	11.6	19	8.8
Plan experiments										
121 special	10	16.9	14	23.7	23	38.9	6	10.1	6	10.1
regular	50	18.7	85	31.9	65	24.4	45	16.9	21	7.8
122 special	19	19.3	28	28.5	24	24.4	10	10.2	17	17.3
regular	30	14.0	52	24.2	65	30.3	39	18.2	26	12.1
Organize facts										
121 special	21	35.5	24	40.6	9	15.2	3	5.0	2	3.3
regular	96	36.0	99	37.2	45	16.9	13	4.8	12	4.5
122 special	40	40.8	27	27.5	18	18.3	7	7.1	6	6.1
regular	69	32.2	76	35.5	49	22.8	12	5.6	8	3.7
Interpret facts										
121 special	17	28.8	22	37.2	13	22.0	7	11.8	0	-
regular	111	41.7	82	30.8	45	16.9	19	7.1	9	3.3
122 special	35	35.6	32	32.6	20	20.4	6	6.1	5	5.1
regular	78	36.4	69	32.2	44	20.5	14	6.5	8	3.7
Scientific method										
121 special	22	37.2	20	33.9	8	13.5	5	8.4	4	6.7
regular	92	34.5	82	30.8	62	23.3	19	7.1	11	4.1
122 special	31	31.6	34	34.6	25	25.5	6	6.1	2	2.0
regular	71	33.1	68	31.7	55	25.7	14	6.5	6	2.8

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XXII

COMPARISON OF RATINGS OF ATTITUDE OBJECTIVES
BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Cause and effect										
121 special	18	30.5	15	25.4	14	23.7	7	11.8	5	8.4
regular	103	38.7	70	26.3	54	20.3	20	7.5	17	6.3
122 special	32	32.6	22	22.4	20	20.4	15	15.3	8	8.1
regular	69	32.2	63	29.4	44	20.4	17	7.9	14	6.5
Openmindedness										
121 special	27	45.7	20	33.9	7	11.8	2	3.3	3	5.0
regular	122	45.7	84	31.5	39	14.6	10	5.7	8	3.0
122 special	41	41.8	35	35.7	16	16.3	3	3.0	3	3.0
regular	89	41.5	62	28.9	39	18.2	15	7.0	4	1.8
Freedom from superstition										
121 special	15	25.4	9	15.2	12	20.3	10	16.9	12	20.3
regular	16	32.3	43	16.1	52	19.5	32	12.0	50	18.7
122 special	26	26.5	16	16.3	23	23.4	12	12.2	21	21.4
regular	56	26.1	34	15.8	51	23.8	22	10.2	47	21.9
Suspend judgment										
121 special	23	38.9	19	32.2	8	13.5	6	10.1	3	5.0
regular	109	40.9	91	34.2	48	18.0	12	4.5	5	1.8
122 special	30	30.1	40	40.8	23	23.4	3	3.0	2	2.0
regular	73	34.1	67	31.3	53	24.7	12	5.6	7	3.2
Freedom from prejudice										
121 special	19	32.2	9	15.2	10	16.9	4	6.7	16	27.1
regular	88	33.0	63	23.6	50	18.7	27	10.1	36	13.5
122 special	27	27.5	22	22.4	19	19.3	10	10.2	19	19.3
regular	61	28.5	49	22.8	46	21.4	23	10.7	28	13.0
Intellectual curiosity										
121 special	20	33.9	15	25.4	13	22.0	9	15.2	2	3.3
regular	94	35.3	77	28.9	60	22.6	16	6.0	18	6.7
122 special	30	30.6	25	25.5	21	21.4	13	13.2	9	9.1
regular	69	32.2	56	26.1	59	27.5	18	8.4	10	4.6

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XXIII

COMPARISON OF RATINGS OF INTEREST OBJECTIVES
BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Professional fields										
121 special	6	10.1	11	18.6	16	27.1	11	18.6	15	25.4
regular	27	10.1	43	16.1	90	33.8	59	22.1	46	17.2
122 special	12	12.2	14	14.3	31	31.6	21	21.4	20	20.4
regular	32	14.9	41	19.2	60	28.0	48	22.4	31	14.5
Avocational rating										
121 special	2	3.3	5	8.4	23	38.9	16	27.1	13	22.0
regular	10	3.7	48	18.0	90	33.8	61	22.9	52	19.5
122 special	7	7.1	13	13.3	36	36.7	22	22.5	18	18.4
regular	23	10.7	33	15.4	61	28.5	40	18.6	49	22.9
Avocational interests										
121 special	3	5.0	7	11.8	18	30.5	15	25.4	16	27.1
regular	10	3.7	32	12.0	90	33.8	71	26.6	57	21.4
122 special	2	2.0	13	13.2	35	35.7	24	24.5	23	23.5
regular	13	6.0	33	15.4	50	23.3	68	31.7	47	21.9
Biological literature										
121 special	6	10.1	12	20.3	10	16.9	20	33.9	11	18.6
regular	13	4.8	42	15.5	84	31.5	56	21.0	71	26.6
122 special	7	7.1	8	8.2	23	23.5	34	34.6	24	24.5
regular	22	10.2	25	11.6	59	27.5	56	26.1	52	24.2

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XXIV

COMPARISON OF RATINGS OF APPRECIATION OBJECTIVES
BY SPECIAL PERMISSION AND REGULAR STUDENTS

Objectives and Groups*	Ratings									
	1		2		3		4		5	
	N	%	N	%	N	%	N	%	N	%
Unsolved problems										
121 special	7	11.8	20	33.9	20	33.9	6	10.1	6	10.1
regular	51	19.1	74	27.8	74	27.8	36	13.5	30	11.2
122 special	7	7.1	26	26.5	31	31.6	18	18.3	16	16.3
regular	48	22.4	50	23.3	58	27.1	33	15.4	20	9.3
Esthetic values										
121 special	2	3.3	6	10.1	18	30.5	15	25.4	17	28.2
regular	12	4.5	31	11.6	89	33.4	59	22.1	67	25.1
122 special	6	6.1	10	10.2	32	32.6	21	21.4	28	28.5
regular	23	10.7	33	15.4	58	27.1	40	18.6	53	24.7
Economic values										
121 special	7	11.8	18	30.5	16	27.1	13	22.0	5	8.4
regular	18	6.8	74	27.8	80	30.0	53	19.9	35	13.1
122 special	7	7.1	16	16.3	37	37.8	23	23.5	15	15.3
regular	18	8.4	48	22.4	75	35.0	44	20.6	24	11.2
Accuracy of science										
121 special	7	11.8	18	30.5	19	32.2	11	18.6	4	6.7
regular	48	18.0	74	27.8	88	33.0	29	10.9	25	9.4
122 special	10	10.2	26	26.5	39	39.7	15	15.3	8	8.1
regular	40	18.6	61	28.5	59	27.5	29	13.5	22	10.2

* Total number in group; 121 special - 58; 121 regular - 266; 122 special - 98; 122 regular - 214.

TABLE XXV

COMPARISON OF RATINGS OF UNDERSTANDING OBJECTIVES
BY MEN AND WOMEN STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Man to environment										
Pre men	58	29.0	73	36.5	51	25.5	9	4.5	8	4.0
women	38	38.7	34	34.6	22	22.4	4	4.0	0	-
121 men	44	33.3	47	35.6	31	23.4	6	4.6	4	3.0
women	6	31.5	8	42.1	3	15.7	2	10.6	0	-
122 men	100	36.1	94	33.9	63	22.7	10	3.6	8	2.8
women	13	37.1	12	34.2	8	22.8	1	2.8	1	2.8
Senior men	5	41.6	4	33.3	3	25.0	0	-	0	-
women	26	36.6	28	39.4	12	16.9	4	5.6	1	1.4
Structures to functions										
Pre men	37	18.5	61	30.5	62	31.0	27	13.5	7	3.5
women	19	19.3	31	31.6	34	34.6	10	10.2	3	3.0
121 men	31	23.4	48	36.3	31	23.4	12	9.0	8	6.0
women	6	31.5	6	31.5	7	36.8	0	-	0	-
122 men	88	31.7	91	32.8	69	24.9	14	5.0	9	3.2
women	12	34.2	8	22.8	8	22.8	5	14.2	1	2.8
Senior men	3	25.0	4	33.3	3	25.0	2	16.6	0	-
women	20	28.1	20	28.1	22	30.9	3	4.2	4	5.6
Apply laws										
Pre men	32	16.0	41	20.5	66	33.0	43	21.5	17	8.5
women	7	7.1	18	18.3	40	40.8	19	19.3	12	12.2
121 men	23	17.4	36	27.2	38	28.7	16	12.1	17	12.8
women	4	21.0	6	31.5	2	10.5	6	31.5	1	5.2
122 men	50	18.0	76	27.4	76	27.4	39	14.0	31	11.1
women	9	25.7	6	17.1	6	17.1	9	25.7	5	14.2
Senior men	4	33.3	2	16.6	3	25.0	3	25.0	0	-
women	20	28.1	8	25.3	20	28.1	11	15.4	2	2.8
Fact from theory										
Pre men	53	26.5	66	33.0	46	23.0	27	13.5	7	3.5
women	27	27.5	29	29.5	32	32.6	7	7.1	2	2.0
121 men	30	22.7	45	34.0	32	24.2	15	11.3	10	7.5
women	7	36.8	3	15.7	4	21.0	5	26.3	0	-
122 men	62	22.3	92	33.2	74	26.7	33	11.9	13	4.6
women	5	14.2	11	31.4	13	37.1	5	14.2	1	2.8
Senior men	7	58.3	1	8.3	4	33.3	0	-	0	-
women	14	19.7	29	40.8	19	26.7	5	7.0	3	4.2

* Total number in group; Pre men - 200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XXVI

COMPARISON OF RATINGS OF INSTRUMENTAL SKILL OBJECTIVES BY MEN AND WOMEN STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Accurate observations										
Pre men	104	52.0	54	27.0	31	15.5	9	4.5	2	1.0
women	49	50.0	30	30.6	16	16.3	0	-	2	2.0
121 men	62	46.9	48	35.6	16	21.1	2	1.5	5	3.7
women	10	52.6	5	26.3	3	15.7	1	5.2	0	-
122 men	126	45.4	91	32.8	40	14.4	9	3.2	11	3.9
women	13	37.1	11	31.4	7	20.0	4	11.2	0	-
Senior men	4	33.5	7	58.3	1	8.3	0	-	0	-
women	32	45.0	22	30.9	13	18.3	4	5.6	0	-
Graphs and tables										
Pre men	12	6.0	32	16.0	50	25.0	45	22.5	58	29.0
women	3	3.0	9	9.1	23	23.4	35	35.6	28	28.5
121 men	6	4.5	16	12.1	42	31.0	22	16.6	46	34.7
women	1	5.2	1	5.2	6	31.5	6	31.5	5	26.3
122 men	13	4.6	38	13.7	72	25.9	63	22.7	90	32.4
women	2	5.7	7	20.0	4	11.3	8	22.8	14	40.0
Senior men	0	-	0	-	2	16.6	2	16.6	8	66.0
women	1	1.4	5	7.0	32	45.0	15	21.1	17	23.9
Scientific apparatus										
Pre men	46	23.0	52	26.0	58	29.0	26	13.0	18	9.0
women	16	16.3	16	16.3	38	38.7	13	13.0	15	15.3
121 men	18	13.6	34	25.7	37	28.0	21	15.9	22	16.6
women	1	5.2	3	15.7	7	36.8	4	21.0	4	21.0
122 men	36	12.9	58	20.9	97	35.0	53	19.0	33	11.9
women	5	14.2	5	14.2	8	22.8	8	22.8	9	25.7
Senior men	1	8.3	2	16.2	5	41.6	4	33.3	0	-
women	1	1.4	14	19.7	26	36.6	21	29.5	8	11.2

* Total number in group; Pre men - 200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XXVII

COMPARISON OF RATINGS OF INSTRUMENTAL SKILL OBJECTIVES BY MEN OF THREE AGE GROUPS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Accurate observations										
Pre 16-19 yrs.	39	52.7	21	28.3	12	16.2	2	2.7	0	-
20-23 yrs.	53	53.5	25	25.2	15	15.1	4	4.0	2	2.0
24 yrs.-up	12	44.4	8	29.6	4	14.8	3	11.1	0	-
121 16-19 yrs.	17	60.7	7	25.0	2	7.1	0	-	2	7.1
20-23 yrs.	30	38.0	34	43.0	11	13.9	2	2.5	2	2.5
24 yrs.-up	15	60.0	6	24.0	3	12.0	0	-	1	4.0
122 16-19 yrs.	7	21.8	19	59.3	3	9.3	1	3.1	2	6.2
20-23 yrs.	95	51.0	56	30.1	22	11.8	6	3.2	7	3.7
24 yrs.-up	24	40.7	16	27.1	15	25.4	2	3.3	2	3.3
Graphs and tables										
Pre 16-19 yrs.	6	8.1	10	13.5	15	20.2	19	25.6	23	31.0
20-23 yrs.	6	6.0	17	17.1	25	25.2	19	19.1	31	31.3
24 yrs.-up	0	-	5	18.5	10	37.0	7	25.9	4	14.8
121 16-19 yrs.	2	7.1	3	10.7	7	25.0	6	21.4	9	32.1
20-23 yrs.	3	3.8	11	13.9	24	30.3	11	13.9	30	38.0
24 yrs.-up	1	4.0	2	8.0	11	44.0	4	16.0	7	28.0
122 16-19 yrs.	2	6.2	5	15.6	6	18.7	11	34.3	8	25.0
20-23 yrs.	8	4.3	29	15.5	48	25.8	41	22.0	59	31.7
24 yrs.-up	3	5.1	4	6.8	18	30.5	11	18.6	23	39.0
Scientific apparatus										
Pre 16-19 yrs.	14	19.1	19	25.6	25	33.7	9	12.1	7	9.4
20-23 yrs.	28	28.2	26	26.2	28	28.2	11	11.1	6	6.0
24 yrs.-up	4	14.8	7	25.9	5	18.5	6	22.2	5	18.5
121 16-19 yrs.	8	28.6	7	25.0	7	25.0	3	10.7	3	10.7
20-23 yrs.	6	7.6	23	29.1	25	31.7	16	20.3	9	11.4
24 yrs.-up	4	16.0	4	16.0	5	20.0	2	8.0	10	40.0
122 16-19 yrs.	1	3.1	6	18.7	14	40.6	6	18.7	5	16.6
20-23 yrs.	28	15.0	40	21.5	67	36.0	30	16.1	21	11.2
24 yrs.-up	7	11.9	12	20.3	16	27.1	17	28.8	7	11.9

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XXVIII

COMPARISON OF RATINGS OF PROBLEM SOLVING SKILL OBJECTIVES BY MEN OF THREE AGE GROUPS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
State problems										
Pre 16-19 yrs.	19	25.6	18	24.3	20	27.0	8	10.8	7	9.4
20-23 yrs.	25	25.2	27	27.2	22	22.2	12	12.1	11	11.1
24 yrs.-up	7	25.9	7	25.9	7	25.9	4	14.8	1	3.7
121 16-19 yrs.	10	35.7	9	32.1	5	17.9	2	7.1	2	7.1
20-23 yrs.	22	27.9	23	29.1	19	24.1	8	10.1	7	8.9
24 yrs.-up	10	40.0	9	36.0	1	4.0	2	8.0	2	8.0
122 16-19 yrs.	8	25.0	8	25.0	7	21.8	6	18.7	3	9.3
20-23 yrs.	66	35.4	42	22.5	38	20.4	23	12.3	16	8.6
24 yrs.-up	17	28.8	15	25.4	14	23.7	7	11.9	6	10.2
Formulate hypotheses										
Pre 16-19 yrs.	14	19.1	27	36.4	19	25.6	10	13.5	4	5.4
20-23 yrs.	27	27.2	38	38.3	17	17.1	13	13.1	3	3.0
24 yrs.-up	6	22.2	9	25.9	6	22.2	5	18.5	3	11.1
121 16-19 yrs.	9	32.1	11	39.3	3	10.7	4	14.3	1	3.6
20-23 yrs.	23	29.1	20	25.3	21	26.6	11	13.9	4	5.1
24 yrs.-up	12	48.0	5	20.0	5	20.0	1	4.0	2	8.0
122 16-19 yrs.	9	28.1	6	18.7	8	25.0	4	12.5	4	12.5
20-23 yrs.	60	32.2	49	26.3	43	23.1	18	9.6	16	8.6
24 yrs.-up	16	27.1	14	23.7	18	30.5	6	10.2	4	6.8
Plan experiments										
Pre 16-19 yrs.	9	12.1	27	36.4	14	19.1	15	20.2	7	9.4
20-23 yrs.	20	20.2	34	34.3	18	18.1	19	19.1	7	7.0
24 yrs.-up	3	11.1	7	25.9	10	37.0	4	14.8	3	11.1
121 16-19 yrs.	8	28.6	7	25.0	8	28.6	2	7.1	3	10.7
20-23 yrs.	11	13.9	20	25.3	23	29.1	17	21.5	8	10.1
24 yrs.-up	9	36.0	7	28.0	4	16.0	4	16.0	1	4.0
122 16-19 yrs.	2	6.3	11	34.3	7	21.8	7	21.8	4	12.5
20-23 yrs.	35	18.8	49	26.3	61	32.7	18	9.6	22	11.8
24 yrs.-up	8	13.6	12	20.3	17	28.8	11	18.6	11	18.6

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XXVIII (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Organize facts										
Pre 16-19 yrs.	31	41.8	20	27.0	16	21.6	5	6.7	1	1.3
20-23 yrs.	39	39.3	35	35.3	18	18.1	4	4.0	3	3.0
24 yrs.-up	9	33.3	10	37.0	5	18.5	1	3.7	2	7.4
121 16-19 yrs.	13	46.4	8	28.6	4	14.3	0	-	3	10.7
20-23 yrs.	24	30.3	34	43.0	12	15.2	6	7.6	3	3.8
24 yrs.-up	15	60.0	5	20.0	4	16.0	0	-	1	4.0
122 16-19 yrs.	8	25.0	11	34.3	10	31.2	1	3.1	2	6.2
20-23 yrs.	74	39.7	60	32.2	33	17.7	11	5.9	8	4.3
24 yrs.-up	17	28.8	23	39.0	14	23.7	2	3.3	3	5.1
Interpret facts										
Pre 16-19 yrs.	27	36.4	26	35.1	15	20.2	5	6.7	1	1.3
20-23 yrs.	41	41.4	34	34.3	20	20.2	2	2.0	2	2.0
24 yrs.-up	13	48.1	8	29.6	4	14.8	1	3.7	1	3.7
121 16-19 yrs.	13	46.4	6	21.4	4	14.3	3	10.7	2	7.1
20-23 yrs.	24	30.3	35	44.3	13	16.5	6	7.6	1	1.3
24 yrs.-up	12	48.0	5	20.0	4	16.0	3	12.0	1	4.0
122 16-19 yrs.	8	25.0	12	37.5	10	31.2	0	-	2	6.2
20-23 yrs.	77	41.3	66	35.4	22	11.8	14	7.5	6	3.2
24 yrs.-up	15	25.4	14	23.7	24	40.7	3	5.1	3	5.1
Scientific method										
Pre 16-19 yrs.	25	33.7	18	24.3	26	35.1	4	5.4	1	1.3
20-23 yrs.	30	30.3	31	31.3	27	27.2	10	10.1	1	1.0
24 yrs.-up	12	44.0	8	29.6	4	14.8	1	3.7	1	3.7
121 16-19 yrs.	5	17.9	12	42.9	7	25.0	2	7.1	2	7.1
20-23 yrs.	20	25.3	29	36.7	19	24.1	10	12.7	1	1.3
24 yrs.-up	9	36.0	11	44.0	3	12.0	0	-	2	8.0
122 16-19 yrs.	10	31.2	10	31.2	11	34.4	1	3.1	0	-
20-23 yrs.	57	30.6	67	36.0	43	23.1	13	6.9	6	3.2
24 yrs.-up	18	30.5	16	27.1	19	32.2	4	6.8	2	3.3

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XXIX

COMPARISON OF RATINGS OF INTEREST OBJECTIVES
BY MEN AND WOMEN STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Professional fields										
Pre men	35	17.5	46	23.0	52	26.0	36	18.0	30	15.0
women	9	9.1	22	22.4	33	33.6	16	16.3	15	15.3
121 men	11	8.3	23	17.4	40	30.3	23	17.4	35	26.5
women	1	5.2	2	10.5	9	47.3	5	26.3	2	10.5
122 men	42	15.1	50	18.0	84	30.3	56	20.2	44	15.8
women	2	5.7	5	14.2	7	20.0	13	37.1	7	20.0
Senior men	4	33.3	2	16.6	3	25.0	3	25.0	0	-
women	6	8.4	12	16.9	30	42.2	17	23.9	6	8.4
Avocational reading										
Pre men	11	5.5	35	17.5	61	30.5	59	29.5	31	15.5
women	3	3.0	19	19.3	28	28.5	25	25.5	19	19.3
121 men	4	3.0	23	17.4	42	31.8	33	25.0	27	20.4
women	1	5.2	1	5.2	6	31.6	10	52.6	1	5.2
122 men	27	9.7	40	14.4	88	31.7	57	20.5	57	20.5
women	3	8.5	6	17.1	9	25.7	5	14.2	10	28.5
Senior men	0	-	2	16.6	4	33.3	2	16.6	4	33.3
women	6	8.4	10	14.0	25	35.2	21	29.5	8	11.2
Avocational interests										
Pre men	9	4.5	28	14.0	66	33.0	53	26.5	42	21.0
women	4	4.0	19	19.3	31	31.6	23	23.4	16	16.3
121 men	3	2.2	17	12.8	43	34.0	33	25.0	32	24.2
women	1	5.2	1	5.2	2	10.5	11	57.8	4	21.0
122 men	14	5.0	41	14.8	80	28.8	80	28.8	59	21.2
women	1	2.8	5	14.2	5	14.2	12	34.2	11	31.4
Senior men	0	-	1	8.6	5	41.6	3	25.0	3	25.0
women	5	7.0	7	9.8	22	30.9	27	38.0	9	12.6
Biological literature										
Pre men	8	4.0	33	16.5	55	27.5	58	29.0	45	22.5
women	3	3.0	11	11.2	35	35.6	24	24.4	25	25.5
121 men	2	1.5	21	15.9	31	23.4	29	21.9	49	37.1
women	1	5.2	3	15.7	6	31.5	6	31.5	3	15.8
122 men	28	10.1	28	10.1	76	27.4	80	28.8	63	22.7
women	1	2.8	5	14.2	6	17.1	10	28.5	13	37.1
Senior men	1	8.3	1	8.3	5	41.6	2	16.6	3	25.0
women	3	4.2	10	14.0	21	29.5	25	35.2	11	15.4

* Total number in group; Pre men - 200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XXX

COMPARISON OF RATINGS OF INTEREST OBJECTIVES
BY MEN OF THREE AGE GROUPS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Professional fields										
Pre 16-19 yrs.	13	17.5	17	22.9	20	27.0	10	13.5	13	17.5
20-23 yrs.	18	18.1	21	21.2	24	24.2	23	23.2	13	13.1
24 yrs.-up	4	14.8	8	29.6	8	29.6	3	11.1	4	14.8
121 16-19 yrs.	4	14.3	7	25.0	7	25.0	4	14.3	6	21.4
20-23 yrs.	4	5.1	13	16.5	24	30.3	16	20.3	22	27.9
24 yrs.-up	3	12.0	3	12.0	9	36.0	3	12.0	7	28.0
122 16-19 yrs.	3	9.3	5	16.6	13	40.6	5	16.6	6	18.7
20-23 yrs.	30	16.1	32	17.2	52	27.9	41	22.0	30	16.1
24 yrs.-up	9	15.3	13	22.0	19	32.2	10	17.0	8	13.6
Avocational reading										
Pre 16-19 yrs.	3	4.0	12	16.2	26	35.1	25	33.9	7	9.4
20-23 yrs.	6	6.0	18	18.1	28	28.2	25	25.0	20	20.2
24 yrs.-up	2	7.4	5	18.5	7	25.9	9	33.3	4	14.8
121 16-19 yrs.	0	-	7	25.0	10	35.7	7	25.0	3	10.7
20-23 yrs.	2	2.5	12	15.2	26	32.9	20	25.3	17	21.5
24 yrs.-up	2	8.0	4	16.0	6	24.0	6	24.0	7	28.0
122 16-19 yrs.	4	12.5	4	12.5	12	37.5	8	25.0	3	9.3
20-23 yrs.	16	8.6	29	15.5	48	25.8	41	22.0	46	24.7
24 yrs.-up	7	11.9	7	11.9	28	47.5	8	13.6	8	13.6

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XXX (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Avocational interests										
Pre 16-19 yrs.	4	5.4	10	13.5	24	32.4	24	32.4	11	14.8
20-23 yrs.	4	4.0	13	13.1	32	32.3	25	25.2	24	24.2
24 yrs.-up	1	3.7	5	18.5	10	37.0	4	14.8	7	25.9
121 16-19 yrs.	1	3.6	4	14.3	12	42.9	4	14.3	6	21.4
20-23 yrs.	0	-	8	10.1	28	35.4	23	29.1	19	24.1
24 yrs.-up	2	8.0	5	20.0	5	20.0	6	24.0	7	28.0
122 16-19 yrs.	1	3.1	4	12.5	10	31.2	13	40.6	4	12.5
20-23 yrs.	8	4.3	29	15.5	51	27.4	52	27.9	43	23.1
24 yrs.-up	5	8.5	8	13.6	19	32.2	15	25.4	12	20.3
Biological literature										
Pre 16-19 yrs.	3	4.0	16	21.6	25	33.7	15	20.2	14	19.1
20-23 yrs.	4	4.0	13	13.1	26	26.2	30	30.3	26	26.2
24 yrs.-up	1	3.7	4	14.8	4	14.8	13	48.1	5	18.5
121 16-19 yrs.	0	-	4	14.3	7	25.0	7	25.0	10	35.7
20-23 yrs.	1	1.3	10	12.7	22	27.9	18	22.8	28	35.4
24 yrs.-up	1	4.0	7	28.0	2	8.0	4	16.0	11	44.0
122 16-19 yrs.	5	16.6	4	12.5	8	25.0	8	25.0	7	21.8
20-23 yrs.	19	10.2	16	8.6	46	24.7	54	29.0	49	26.3
24 yrs.-up	4	6.8	8	13.6	22	37.3	18	30.5	7	11.9

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XXXI

COMPARISON OF RATINGS OF APPRECIATION OBJECTIVES
BY MEN AND WOMEN STUDENTS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Unsolved problems										
Pre men	56	28.0	49	24.5	53	26.5	24	12.0	17	8.5
women	26	26.5	23	23.4	20	20.4	20	20.4	9	9.1
121 men	23	17.4	35	26.5	38	28.7	17	12.8	19	14.3
women	5	26.3	6	31.5	6	31.5	2	10.5	0	-
122 men	44	15.8	68	24.5	80	28.8	47	16.9	33	11.9
women	11	31.4	8	22.8	9	25.7	4	11.4	3	8.5
Senior men	3	25.0	3	25.0	2	16.6	1	8.3	3	25.0
women	12	16.9	19	26.7	22	30.9	8	11.2	10	14.0
Esthetic values										
Pre men	26	13.0	37	18.5	61	30.5	50	25.0	24	12.0
women	13	13.2	17	17.3	33	33.6	21	21.4	10	10.2
121 men	4	3.0	10	7.5	51	38.6	25	18.9	41	31.0
women	2	10.5	3	15.7	4	21.0	5	26.3	4	21.0
122 men	26	9.3	39	14.0	82	29.6	52	18.7	70	25.2
women	3	8.5	4	11.2	8	22.8	9	25.7	11	31.4
Senior men	0	-	1	8.3	4	33.3	4	33.3	3	25.0
women	6	8.4	9	12.6	21	29.5	18	25.3	17	23.9
Economic values										
Pre men	20	10.0	53	26.5	68	34.0	41	20.5	16	8.0
women	5	5.1	22	22.4	35	35.6	25	25.5	7	7.1
121 men	8	6.0	38	28.7	35	26.5	29	21.9	20	15.1
women	1	5.2	4	21.0	9	47.3	3	15.7	2	10.5
122 men	23	8.3	60	21.6	96	34.6	60	21.6	34	12.2
women	2	5.7	4	11.2	16	45.7	7	20.0	5	14.2
Senior men	2	16.6	2	16.6	5	41.6	1	8.3	2	16.6
women	7	9.8	17	23.9	25	35.2	8	11.2	9	12.6
Accuracy of science										
Pre men	33	16.5	64	32.0	61	30.5	29	14.5	12	6.0
women	13	13.2	21	21.4	37	37.7	19	19.3	7	7.1
121 men	22	16.6	41	31.0	35	26.5	17	12.8	15	11.3
women	4	21.0	9	47.3	3	15.7	3	15.7	0	-
122 men	46	16.6	73	26.3	91	32.8	38	13.7	26	9.3
women	4	11.2	14	40.0	7	20.0	6	17.1	4	11.2
Senior men	3	25.0	3	25.0	3	25.0	1	8.3	2	16.6
women	4	5.6	17	23.9	29	40.8	16	22.5	5	7.0

* Total number in group; Pre men - 200; Pre women - 98; 121 men - 132; 121 women - 19; 122 men - 277; 122 women - 35; Senior men - 12; Senior women - 61.

TABLE XXXII

COMPARISON OF RATINGS OF APPRECIATION OBJECTIVES
BY MEN OF THREE AGE GROUPS

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Unsolved problems										
Pre 16-19 yrs.	18	24.3	20	27.0	20	27.0	11	14.8	5	6.7
20-23 yrs.	32	32.3	19	19.1	25	25.2	11	11.1	11	11.1
24 yrs.-up	4	22.2	10	37.0	8	29.6	2	7.4	1	3.7
121 16-19 yrs.	4	14.3	10	35.7	7	25.0	5	17.9	2	7.1
20-23 yrs.	14	17.7	19	24.1	26	32.9	11	13.9	9	11.4
24 yrs.-up	5	20.0	6	24.0	5	20.0	1	4.0	8	32.0
122 16-19 yrs.	3	3.1	6	18.7	9	28.1	4	12.5	8	25.0
20-23 yrs.	28	15.0	49	26.3	57	30.6	37	19.8	13	6.9
24 yrs.-up	13	22.0	13	22.0	14	23.7	6	10.2	12	20.3
Esthetic values										
Pre 16-19 yrs.	9	12.1	16	21.6	24	32.4	16	21.6	9	12.1
20-23 yrs.	14	14.1	15	15.1	29	29.2	28	28.2	11	11.1
24 yrs.-up	3	11.1	6	22.2	8	29.6	6	22.2	4	14.8
121 16-19 yrs.	1	3.6	2	7.1	12	42.9	7	25.0	6	21.4
20-23 yrs.	2	2.5	5	6.3	32	40.5	17	21.5	23	29.1
24 yrs.-up	1	4.0	3	12.0	7	28.0	1	4.0	12	48.0
122 16-19 yrs.	7	21.8	1	3.1	10	31.2	6	18.7	8	25.0
20-23 yrs.	15	8.1	28	15.0	51	27.4	37	19.8	47	25.2
24 yrs.-up	4	6.8	10	17.0	21	35.6	9	15.3	15	25.4

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.

TABLE XXXII (continued)

Objectives and Groups*	Ratings 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %
Economic values										
Pre 16-19 yrs.	8	10.8	22	29.7	28	37.8	11	14.8	4	5.4
20-23 yrs.	8	8.0	23	23.2	32	32.3	25	25.2	10	10.1
24 yrs.-up	4	14.8	8	29.6	8	29.6	5	18.5	2	7.4
121 16-19 yrs.	2	7.1	10	35.7	7	25.0	6	21.4	3	10.7
20-23 yrs.	4	5.1	24	30.3	21	26.6	16	20.3	13	16.5
24 yrs.-up	2	8.0	4	16.0	7	28.0	7	28.0	4	16.0
122 16-19 yrs.	2	6.2	8	25.0	11	34.4	10	31.0	0	-
20-23 yrs.	15	8.0	42	22.5	64	34.4	38	20.4	27	14.5
24 yrs.-up	6	10.2	10	17.0	21	35.6	7	20.3	3	5.1
Accuracy of science										
Pre 16-19 yrs.	18	24.3	22	29.7	20	27.0	8	10.8	6	8.1
20-23 yrs.	14	14.1	35	35.3	26	26.2	18	18.1	6	6.1
24 yrs.-up	1	3.7	7	25.9	15	55.6	3	11.1	0	-
121 16-19 yrs.	3	10.7	10	35.9	10	35.9	1	3.6	4	14.3
20-23 yrs.	15	19.0	25	31.7	18	22.8	14	17.7	6	7.6
24 yrs.-up	4	16.0	6	24.0	7	28.0	2	8.0	5	20.0
122 16-19 yrs.	5	16.6	8	25.0	12	37.5	5	16.6	2	6.2
20-23 yrs.	34	18.2	48	25.8	57	30.6	27	14.5	17	9.1
24 yrs.-up	7	11.9	17	28.8	22	37.3	6	10.2	7	11.9

* Total number in group; Pre 16-19 yrs. - 74; Pre 20-23 yrs. - 99; Pre 24 yrs.-up - 27; 121 16-19 yrs. - 28; 121 20-23 yrs. - 79; 121 24 yrs.-up - 25; 122 16-19 yrs. - 32; 122 20-23 yrs. - 186; 122 24 yrs.-up - 59.