THE RELATIONSHIP AMONG NUMBER OF HIGH SCHOOL SCIENCE COURSES, ATTITUDE TOWARDS SCIENCE AND BIOLOGY ACHIEVEMENT IN NONSCIENCE-MAJORS

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CHAPTER I

INTRODUCTION

The newer concepts of science, as developed during the past century, tend to focus more and more on how to understand the world around us (39). Today science is a part of everyday life, even a part of our culture. Dr. K. Uian (14) has stated that no one can be liberally educated without an understanding of science; that science (and mathematics) are basic cultural subjects and should be taught as cultural disciplines. Le Corbeiller (15) also said that a genuine knowledge of basic sciences must be the possession of every individual.

Experts in science education believe that science programs can be developed that will produce a more science oriented student who is better able to understand and solve the problems of everyday living. The scientific method for solving problems is one of the most important tools of the scientist and is equally important to the nonscientist (31). If people are to live fully and abundantly in a society that is strongly influenced by science and technology, they must have a real understanding of these forces and be able to use them to full advantage (19).

Both science and nonscience students have a need for science education that relates the facts and principles of science to their everyday living. It is the educational goal to prepare people for earning their living and using the scientific method for solving problems in a variety of everyday life situations.

The purpose of general education is to meet the needs of individuals in the basic aspects of living in such a way as to promote the fullest possible realization of personal potentialities and the most effective participation in a democratic society (28). Survey courses are developed with the intent of extending the breadth of knowledge and the diversity of the intellectual skills of students (22).

According to Stavick (32), students who take Biological Science as general education survey courses on the college level have different backgrounds. These differences are partly due to the new science programs that are offered to some students and not to others. At the present time many science curricula in the secondary schools endeavor to give students a basic understanding of science. The programs intend to improve the preparation of youth for life in a highly complex and troubled world. Among these science curricula are The Biological Science Curriculum Study (BSCS), The Physical Science Study Committee (PSSC), Introductory Physical Science (IPS), The Chemical Education Material Study (CHEM STUDY), The Chemical Bond Approach (CBA), The Earth Science Curriculum Program (ESCP), The Engineering Concepts Curriculum Project (ECCP), and The Secondary School Science Project (SSSP). The differences in individual achievement in a course may depend upon the students' academic backgrounds and the development of attitudes and understandings of the students. Henson (13) stated that the attitude of the student towards his school work may be involved in his achievement and attitude may be the factor that contributes the most to achievement.

Biological Sciences offered at Oklahoma State University is an interdisciplinary "core" curriculum in biology. The student who does not intend to major in science may take courses in Biological Sciences to fulfill his general education requirement. Biological Sciences provide a broad view of living things with an emphasis on biological principles. The subject matter is directly concerned with living organisms and with the life processes of these organisms; and is also concerned with relationships of organisms in both biological and physical environments. Classes are specifically designed to stimulate an interest in, and appreciation of, the living world around us.

Background for the Study

Several studies have dealt with the relationship of attitudes toward school or toward a specific subject matter and achievement. Brown's (1) study was made to determine whether there was a relationship between intellectual attitudes or breadth of intellectual interests and academic achievement among college freshman. In his study he found significant correlations between all of the intellectual attitude scales and all of the intellectual activity indices. The result from the study of Neidt and Hedlund (25) indicated that student attitudes toward a particular learning experience do become progressively more closely related to achievement in the learning experience as the period of instruction progresses. There were interesting possibilities of influencing student achievement through modification of attitude towards a class. Willoughby (38) also said that the course grades variable is significantly related to attitude towards college.

Butts and others (3) said the following about personal interaction context in the education experience:

> Based on this concept of education as an interaction of individuals with experiences, what the learner does depends upon the varied cues which he perceives within his experiences. Those cues that are perceived will be dependent upon his previous experiences and his personal attitudes, insights, and interests which he brings to the experience (p. 11).

From this point of view the student's achievement in the course may depend upon his previous experiences and his attitudes.

Statement of the Problem

The investigator has been interested in the introductory courses in science for nonscience-major college students and the factors which may influence the achievement in science of those students. Many investigators have sought answers to the problem of individual differences in course achievement. Numerous variables have been studied. These included interest, ability, attitude and motivational factors (5).

This study was undertaken to determine if the number of science courses taken in high school is related to further achievement in biology and a more positive attitude towards science in college; and whether or not the attitude towards science is related to biology achievement in nonscience-major college students.

Statement of the Hypotheses

The hypotheses to be tested in the null will be the following.

1. There is no significant relationship between the number of high school science courses taken and biology achievement in non-

science-major college students.

2. There is no significant relationship between the number of high school science courses taken and attitude towards science in nonscience-major college students.

3. There is no significant relationship between attitude towards science and biology achievement in nonscience-major college students.

Significance of the Study

Biological Science is an important component of our culture, which should be appropriately represented in the background of every well-educated person. Colleges and universities share with secondary schools the responsibility for supplying this understanding (29).

The purpose of this study is to determine possible factors which may influence the achievement of the student in biology at the college level. Among the possible factors are the science background (in term of the number of high school science courses taken) and attitude towards science of the student. This study also attempts to investigate whether the science background is related to the attitude of the nonscience-major college student towards science.

The results of the study may be expected to help the preparation of high school students before entering colleges or universities. If significant relationships among science background, attitude towards science, and biology achievement are found, this would suggest an increase in the number of science courses offered at the high school level. If there is a positive attitude towards science in nonscience students, it seems to indicate an understanding of the significance and the usefulness of science. They may understand how the world has changed and is being changed by science and appreciate the world in which they live, based on a knowledge of the universality of cause and effect and not on superstition, magic and/or fortune-telling. They know they can use the facts and principles of science to improve themselves and society. The processes of science will help people find better ways of solving problems.

A basic understanding of biological principles, which are universal in nature, is an important facet to intellectual growth and mental maturity in today's technological community (12). Biological Sciences should be taught as a general education courses for nonscience-majors at the college level.

Limitation of the Study

This study was limited to the population of students at Oklahoma State University taking Biological Science 1114, an interdisciplinary core course for students who are nonscience-majors. A total of 114 students were involved in this study.

Definition of Terms

Attitude Towards Science: Attitude towards science refers to how an individual feels about science; and emotional feeling for or against science as exhibited by the behavior of the individual. Attitude towards science in this study is defined in terms of the *Scientific Attitude Inventory*.

Biological Science 1114: Biological Science 1114 is a four semester-hour course. It is offered for nonscience-majors. It deals with ecological principles, population, man and environment; genetics;

reproduction and development; concepts of evolution, selection and adaptation.

Biology Achievement: Biology achievement in this study refers to the student's acquisition of biological knowledge as demonstrated by his performance on the Nelson Biology Test, Form E.

Interdisciplinary Core Course: Interdisciplinary core course is the course which may be used by the student to fulfill his general education requirement.

Number of High School Science Courses: The number of high school science courses refers to the number of science courses (e.g. biology, chemistry, earth science, physics and geology) the student had taken in high school.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The world today is increasingly being influenced, and even dominated, by science and technology. It appears that society as a whole accepts the importance of science. Science is concerned with natural phenomena. It is closely related to the everyday experience of student. The student should seek to understand and to explain events found in the natural world. He should grow in his ability to engage in the processes of science and to apply these processes in appropriate situations as he confronts them in his daily life.

There are increasing amounts of science being taught not only in the elementary schools but in the junior and senior high schools and through all general education (18, 26, 39). The goal of developing scientific literacy and understanding of science on the part of all students is an extremely important part of curriculum development.

Educators should try to find ways to assist students to be successful in science education. Many studies have been made to determine factors which may cause the students' success or failure. The science background and attitude are among the possible factors.

The Significance of Science

Science is a process of thinking, a means of acquiring new knowledge and a means of understanding through experimentation, generalizations, theories, and explanation about, and relationships and interconnections among observed facts in nature (8, 16, 19).

Meiller (23) expressed his viewpoint of science as:

> Science is a search for the truth. In the search for truth the student should develop attitudes of critical thinking. He should be aware of his responsibility of living within our scientific environment. In his search for truth the student should develop attitudes of confidence in his integral part in the purpose and plan of the universe. His attitudes should be based on an understanding of the fundamental laws governing our universe. This understanding should lead the student to appreciate the significance of science in a changing world. To further his learning the student should develop skills necessary to manipulate his environment for the better ment of mankind (p. 717).

Tiffney (35) said about the significance of science in "The Science Program in the Boston University General College":

> Science is so vitally a part of our national and international life and culture that it is highly desirable for today's citizens to have an appreciation of its achievements of an intellectual and philosophical nature and its utilitarian applications, as well as an understanding of its dangers and limitations (pp. 171-172).
>
> The purpose of the science program is to give a clear understanding of the achievements of the principal sciences, to demonstrate the relationship between the laws of science and the world of nature, and to promote a thorough understanding of the scientific method in order to show how scientific development has made for cultural progress and growth. The method of presentation is planned not only to make the student familiar with the fundamental principles of each science but also, by acquainting him with the role of science in the modern world, to provide that scientific understanding essential to a liberal education (p. 172).

Science is a part of everyday life therefore nonscience students as well as science majors need to have a fundamental grasp of the facts and principles of science. It is necessary for an educated person to think in a scientific manner and to be able to use the scientific method in solving problems in order to live happily and successfully in the modern world. Science education can help to develop abilities to cope with problematic life situations. Science in itself cannot solve problems but science can furnish people with facts and concepts that may be applied to their effective solution (39).

Byers (4) indicated that the university graduate should know about Darwin as well as about Shakespeare; should know about scientific principles as well as about ethical or political one.

Le Corbeiller (15) stated:

> The scientist or engineer needs the knowledge of the basic science in order to see his own specialized work in the perspective of an over-all scientific and technical pattern. The nonscientist needs exactly the same basic scientific training because a glance at science from the outside will never give him an understanding of the inner springs of this new intellectual power (p. 3).

Sheppard (31) also agreed that the scientific method for solving problems is one of the most important tools of the scientist and is equally important to the nonscientist.

Science in General Education

General education is an education which is nonspecial, or which is not an immediate part of the specialization. It gives the basic fundamental values and purpose of life. General education need not start the training of professional scientists or try to equip everyone with a lot of scientific knowledge but it does need to provide an understanding of science and its contributions to the intellectual, spiritual, and physical aspects of life.

Science should be a basic part of general education for all students. Karplus and Thier (18) support this statement:

It is already clear that science plays a major role in all

> human activities, ranging from everyday living to world politics. It is also clear that science will continue to play an increasing important role in every individual's life, whether he may have chosen science as a profession or not. In order to prepare an individual for life in a society where science plays such an important role, one would expect science to be prominent in any curriculum (p. 9).

Colleges have defended the use of science courses for general education in the following ways (30):

> A thorough grounding in science gives a good idea of the nature of science
>
> An acquaintance with the main facts of a science is itself a valuable part of education for civilized life
>
> Work in science gives training in scientific method--that is, it makes people more scientific--a virtue to be transferred to other studies and other activities in general life
>
> A taste of science in a first college course gives some students a chance to decide they will be scientists (p. 3).

The program of general education at Oklahoma State University had its beginning in the School of Arts and Sciences in the Fall of 1935 (Oklahoma State University was Oklahoma Agricultural and Mechanical College then) (36). The rise in popularity of general education gave birth to college-level courses in science for the nonscientist. The two introductory general education courses in science are physical sciences and biological sciences. The course in physical sciences is conceived as a selection of basic materials from physics, chemistry, geology and astronomy. The biological sciences course is a survey of the basic concepts and principles of the biological sciences.

Biological Science as General Education

Biological science attempts to coordinate the living world as a complete unit interacting and reacting with its physical environment, including subunits of microscopic dimensions which are directed and governed by the same identical laws of biochemistry and biophysics. Man must learn that he is a part of the biosphere and not above and beyond it and that through education he can impart the knowledge necessary for an awareness of his place in the balance of nature.

The program in biological sciences provides the understanding of biology essential for every college student. The program conveys the nature of scientific processes and the investigative method, including some history of biology; develops an understanding of and interest in living organisms through a comprehension of important biological concepts; represents biology as a growing field which uses techniques and ideas from many sources; provides substantial field and laboratory experience; and relates biological sciences to man's other intellectual, cultural and practical activities.

An education should be designed to enable an individual to better cope with his environment. The study of biology is, therefore indispensable for an educated man.

The Conference on Undergraduate Curricula in the Biological Sciences unanimously adopted the following resolution in 1957 (29):

> We believe that every educated person should obtain a sound knowledge and appreciation of the biological sciences. This may be attained through precollege courses, introductory college courses in biology. . . . Biologists should make every effort to maximize opportunity and motivation young people to acquire at least this level of understanding of biology (p. 9).

Students enrolled in a biological science course want to understand and modify their environment as a result of their general education.

Scientific Attitudes

Attitudes are defined in a wide variety of ways by many authors. Falk (8) defined attitude as the settled behavior or manner of acting. An attitude represents both an orientation toward or away from some objects, concept or situation and a readiness to respond in a predetermined manner to these or related objects, concepts or situations. Attitudes develop through many learning experiences.

Allport (37) saw attitude as:

> . . . mental and neural state of readiness organized through experience, exerting a direction and dynamic influence upon the individual's response to all objects and situations with which it is related (p. 5).

Sorenson (37) was more specific:

> An attitude is a particular feeling about something. It therefore involves a tendency to behave in a certain way in situations which involve that something, whether person, idea, or object. It is partially rational and partially emotional and is acquired, not inherent, in an individual (p. 5).

Scientific attitudes might be interpreted either as attitudes which have existed in the mind of outstanding men of science, or as the attitudes which tend to foster scientific achievement (5). Noll (27) gave six components of scientific attitude as follows: (1) Habit of accuracy in all operations, including accuracy in calculation, observation and report, (2) Habit of intellectual honesty, (3) Habit of open-mindedness, (4) Habit of suspended judgement, (5) Habit of looking for true cause and effect relationships, and (6) Habit of criticalness, including that of self-criticism.

Curiosity and the spirit of inquiry are a part of what is known as scientific attitude. Scientific attitude is becoming well established when one become a close observer and, through observation and experimentation, discovers facts for himself; develops a wider and deeper understanding of the world about and a willingness to change his ideas as a result of new evidence; understands how the world has changed and is being changed by science; realizes the danger of scientific knowledge outstripping the world's sense of social responsibility; builds a wholesome appreciation of the world in which he lives based on a knowledge of the universality of cause and effect and not on superstition, magic, prejudice, and fortune-telling; rejects personification, mysticism, and gossip in making explanation; acquires a pleasant and profitable leisure-time activity; realizes that some natural phenomena have not been satisfactorily explained by scientists; strives for accuracy in work and thinking (10).

Noll (27) reported that the possession of the scientific attitude by people is one of great importance in helping them understand and properly interpret scientific knowledge and method as well as many other things concerning our daily lives. Gladstein (11), Butts (3) and Wethington (37) agree that attitudes develop as a result of the previous experiences. The attitudes of the students toward science are strongly influenced by their experiences with this subject in the lower grades (18).

Attitude and Academic Achievement

Attitude is an important variable in learning. It is one among other factors which influences a student's academic success. Chuaphanich (5) classified the factors influencing students' achievement in college as: (a) intellective factors (measures of IQ, aptitude, and prior achievement); and (b) non-intellective factors (measures of personality, motivation, attitude, and conception). McCausland and Stewart (21) and Gladstein (11) have the same idea that the attitudes of a student are among most important factors that will determine his success in college. Chuaphanich (5) refering to Mallinson's investigation indicates that there was a definite relationship between success in college science and a student's interest in high school science.

Wethington (37) said that attitudes usually reflect the student's success in a particular subject; and also stated the importance of attitudes:

> Attitudes are important. What a person is and what he may become, whether he succeeds or fails, achieves satisfaction or not, approaches his potential or allows his talents to remain undeveloped or underdeveloped, rests not alone upon the smile of fortune--a quick intelligence, a healthy body, the knock of opportunity--but also and perhaps ultimately upon the attitudes he has acquired. Of particular interest to school people, especially teachers, is the nature of attitudes, how they are acquired, developed and modified, and, most importantly, the degree to which they are related to pupil achievement in the subject matter areas (p. 5).

Many studies have investigated the relationship of the attitude towards school subjects and achievement. Ellis (7) found that there is a positive correlation between a student's attitude towards the educational institution he attends and his academic achievement. This finding suggests some conflict with the finding of Willoughby (38). Willoughby found the course grades variable was not significantly related to the attitudes toward college. There are possibilities of influencing student achievement through student's attitude towards class. The findings of many authors appear to have significant correlations between the student's success in course and student's attitude towards that course (1, 25, 38).

Many studies reported in the literature discuss the relationship between attitude and the success in class. However, the writer could not find any that delt specifically with the study of science.

CHAPTER III

METHOD AND DESIGN

Introduction

The first objective of this study was to determine whether or not the number of high school science courses and attitude towards science influenced the achievement and understanding of biology in nonscience-major students at the college level. Secondly, this study attempted to investigate if the number of high school science courses affected attitudes toward science.

Characteristics of Biological Science 1114

Biological Science 1114 is an interdisciplinary "core" curriculum; a four semester-hour general biology course offered at Oklahoma State University, primarily for nonscience-majors. The sequence topics taught in this course are ecosystem, biogeographical regions, succession, population dynamics, man and ecosystem, basic cell structure, mitosis, meiosis, genetics, development, protein synthesis, population genetics, adaptation and speciation, adaptive radiation, isolation mechanisms, evolution and history of life on earth.

The students who do not intend to major in science may take Biological Science 1114 to fulfill their requirement in general education. The students enrolled in this course come from several of the colleges of the university including the Colleges of Arts and Sciences, Business Administration, Education, and Home Economics.

Design of the Study

A total of one hundred fourteen college students enrolled in Biological Science 1114 in the Spring semester of 1977 served as subjects for the study. Students participating in this study came from one section of the course and were under one professor, Dr. Calvin M. Cunningham, Sr.

All subjects were administered the Nelson Biology Test, Form E (Appendix C), the Scientific Attitude Inventory (Appendix D), and a short information sheet (Appendix A). The students were asked to fill out the short information sheet to specify the number of high school science courses they had taken.

Instrumentation

The tests used were the Nelson Biology Test, Form E (to determine the achievement in biology) and the Scientific Attitude Inventory (to determine the attitude towards science). On the short information sheet each subject was to specify the number of high school science courses he or she had taken.

The instruments used in this study are reliable and have been used by other investigators. The short description of the two instruments follows.

The Nelson Biology Test, Form E was discussed by Stavick (32) as the following:

> The revision of the Nelson Biology Test in 1965, was

conducted in accordance with the standards established by the Committee on Test Standards, American Educational Research Association and the National Council on Measurements Used in Education.

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

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

Sixty-five test items were selected by Nelson, using as criteria the frequency of their inclusion in current science education materials and recommendations by notable experts in the field of science education. Table I provides an item classification of the Nelson Biology Test, Form E in the cognitive and content categories (pp. 31-33).

The Scientific Attitude Inventory is the test instrument which assesses some of the elements in each subdivision of the universe of content--scientific attitudes. The universe of content "scientific attitudes" includes intellectual and emotional scientific attitudes. Intellectual Attitudes are said to be based upon some knowledge about the psychological object of the attitudes, and Emotional Attitudes are said to be based upon a feeling of emotional reaction to the psychological object of the attitudes.

The development of the Scientific Attitude Inventory was to provide a useful, valid and reliable inventory of scientific attitudes

TABLE I

ITEM CLASSIFICATION OF THE NELSON BIOLOGY TEST, FORM E

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

for use at the high school level. The attitudes to be assessed by the Scientific Attitude Inventory (24) are listed below.

Scale
1-A The laws and/or theories of science are approximations of truth and are subject to change.
1-B The laws and/or theories of science represent unchangeable truths discovered through science.
2-A Observation of natural phenomena is the basis of scientific explanation. Science is limited in that it can only answer questions about natural phenomena and sometimes it is not able to do that.
2-B The basis of scientific explanation is in authority. Science deals with all problems and it can provide correct answers to all questions.
3-A To operate in a scientific manner, one must display such traits as intellectual honesty, dependence upon objective observation of natural events, and willingness to alter one's position on the basis of sufficient evidence.
3-B To operate in a scientific manner, one needs to know what other scientists think; one needs to know all the scientific truths and to be able to take the side of other scientists.
4-A Science is an idea-generating activity. It is devoted to providing explanations of natural phenomena. Its value lies in its theoretical aspects.
4-B Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses.
5-A Progress in science requires public support in this age of science, therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.
5-B Public understanding of science would contribute nothing to the advancement of science or to human welfare, therefore, the public has no need to understand the nature of science. They cannot understand it and it does not affect them.
6-A Being a scientist or working in a job requiring scientific knowledge and thinking would be a very interesting and rewarding life's work. I would like to do scientific work.
6-B Being a scientist or working in a job requiring scientific knowledge and thinking would be dull and uninteresting; it is only for highly intelligent people who are willing to spend most of their time at work. I would not like to do scientific work (pp. 86-87).

The first six position statements listed above emphasize intellectual attitudes, and the last six statements emphasize emotional attitudes. Also, the position statements labelled "A" are a sample of positive attitudes with respect to science, and the statements labelled "B" are a sample of negative attitudes with respect to science. The position statement in each pair (e.g., 1-A and 1-B) are intended to be in opposition to each other.

The Inventory was field tested and validated in two administrations to three groups of students. One group received instruction to develop positive scientific attitudes; a second group received instruction to develop positive scientific attitudes and to eliminate negative scientific attitudes; and a third group was used as a control --receiving no instruction relative to the assessed attitudes. The changes from pre-test to post-test were in accord with theoretical prediction, hence, construct validity is claimed.

The reliability of the Scientific Attitude Inventory was determined by using the test-retest method described by Winer. The test-retest reliability coefficient obtained by this method is 0.934.

Statistical Analysis

The Pearson Product-Moment Correlation (r) was used to determine if there were significant relationships between (1) the number of high school science courses and biology achievement, (2) the number of high school science courses and attitudes toward science, and (3) attitudes toward science and achievement in biology of nonscience college students. The number of subjects participating in this study was 114 which is larger than 30, therefore, the critical-ratio z-test was used to test the significance of r. The z-value is computed by

$z = r\sqrt{N-1}$ (2). If z for one-tailed test was greater than 2.33 then r was significant at the .01 level.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

Introduction

This chapter presents the analysis of the data. The data used in this study was obtained from one hundred fourteen students enrolled in Biological Science 1114 in the Spring semester of 1977 at Oklahoma State University. The Nelson Biology Test, Form E, the Scientific Attitude Inventory, and a short information sheet were administered to the subjects. The .01 level of confidence was used to determine significance on all tests. The presentation and the statistical analysis of the data follows.

The Student Data

Data concerning three variables, number of high school science courses, biology achievement scores, and attitude towards science were used in this study. Appendix B presents the number of high school science courses in which each student was enrolled; the number of college science courses in which each student was enrolled; the Nelson Biology Test scores, and the Scientific Attitude Inventory scores of each student.

The mean score and the standard deviation of each variable are shown in Table II. The mean score of science courses the students had

TABLE II

MEAN AND STANDARD DEVIATION OF NUMBER OF HIGH SCHOOL SCIENCE COURSES, NUMBER OF COLLEGE SCIENCE COURSES, BIOLOGY SCORES, AND ATTITUDE TOWARDS SCIENCE SCORES
(N = 114)

Variables	Mean	Standard Deviation
HSSC	4.00	2.14
CSC	1.36	1.80
BIOL	32.03	10.01
ATS	112.29	12.93

HSSC = number of high school science courses

CSC = number of college science courses

BIOL = biology achievement scores

ATS = attitude towards science scores

from high school is 4.00 and the standard deviation is 2.14. The score of the Nelson Biology Test, Form E is 65. The mean score of the students for the Nelson Biology Test, Form E is 32.03 and the standard deviation is 10.01. The score of the Scientific Attitude Inventory is 180. The mean score of the students for the Scientific Attitude Inventory is 112.29 and the standard deviation is 12.93.

Table III presents the correlation coefficients between the variables, number of high school science courses, number of college science courses, biology achievement scores, and attitude towards science scores. The correlations between biology achievement scores and number of high school science courses is 0.38, biology achievement scores and attitude towards science scores is 0.31, and number of high school science courses and attitude towards science scores is 0.06.

Testing the Hypotheses

Each null hypothesis was tested using the Pearson Product-Moment Correlation (r). Since the level of significance is $p = .01$, two null hypotheses were rejected and one null hypothesis was accepted at this level.

Hypothesis 1. There is no significant relationship between the number of high school science courses taken and biology achievement in nonscience-major college students.

The result of the study revealed that the r-value between the number of high school science courses and the Nelson Biology Test, Form E scores was 0.38 (Table III). The critical-ratio z-test was used to test the significance of r because the number of the subjects

TABLE III

CORRELATION COEFFICIENTS BETWEEN THE VARIABLES
(N = 114)

	HSSC	CSC	BIOL	ATS
HSSC	1.00	0.31	0.38	0.06
CSC	0.31	1.00	0.28	0.27
BIOL	0.38	0.28	1.00	0.31
ATS	0.06	0.27	0.31	1.00

HSSC = number of high school science courses

CSC = number of college science courses

BIOL = biology achievement scores

ATS = attitude towards science scores

was larger than 30. The z-value was computed by $z = r\sqrt{N-1}$. When $r = 0.38$, $N = 114$, then, $z = 4.04$. Using one-tailed test, the z-value was greater than 2.33, then r was significant at the .01 level. This means that there is a significant relationship between the number of high school science courses taken and biology achievement in nonscience college students. Therefore, Hypothesis 1 can be rejected at the .01 level of significance.

<u>Hypothesis 2</u>. There is no significant relationship between the number of high school science courses taken and attitude towards science in nonscience-major college students.

The r-value of 0.06 (Table III) showed the low correlation between the number of high school science courses and attitude towards science. The computed z-value was 0.64, then, there is no significant relationship between these two variables. Therefore, Hypothesis 2 must be accepted at the .01 level of significance.

<u>Hypothesis 3</u>. There is no significant relationship between attitude towards science and biology achievement in nonscience-major college students.

The correlation between attitude towards science scores and the <u>Nelson Biology Test</u>, <u>Form E</u> scores was 0.31 (Table III). The computed z-value was 3.30, then, there is a significant relationship between attitude towards science and biology achievement in nonscience-major college students. Therefore, Hypothesis 3 can be rejected at the .01 level of significance.

CHAPTER V

SUMMARY OF THE STUDY, RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Study

Today science is a part of everyday life therefore both science and nonscience students have a need for education that relates the facts and principles of science to their everyday living. Biological Science 1114 provides the understanding of biology essential for every college student. The program conveys the nature of scientific processes and develops an understanding of living organisms.

The purpose of the study was to determine if the number of high school science courses and attitude towards science are the possible factors which may influence biology achievement in nonscience-majors at the college level. The study also investigated whether or not the number of high school science courses is related to the attitude towards science of nonscience college students.

One hundred fourteen college students enrolled in Biological Science 1114 in the Spring semester of 1977 were administered the <u>Nelson Biology Test, Form E</u>, the <u>Scientific Attitude Inventory</u>, and a short information sheet. The statistical analysis used in the study was the Pearson Product-Moment Correlation (r). The .01 level of significance was used on all tests in the study.

Results

The following results were obtained from this study.

1. There was a significant relationship between the number of high school science courses and biology achievement in nonscience-major students at the college level. The data indicated that the number of high school science courses has influenced the achievement in biology of nonscience college students.

2. The number of high school science courses has not affected the student's attitude towards science in nonscience-majors. The low correlation between these two variables as shown in Table III indicated that there was no significant relationship between the number of high school science courses and attitudes toward science of nonscience college students.

3. There was a significant relationship between the attitude towards science and the student's achievement in biology. This result agreed with Brown (1), Henson (13), Stavick (32), Willoughby (38), and others that attitudes of the students toward a particular subject tends to be a factor that increases achievement in that subject.

Conclusions

The results of this study revealed that the number of high school science courses influenced biology achievement in nonscience-majors at the college level. It can be stated that there is a need for high school students to have an appropriate number of science courses before entering college. The mean score of the number of science courses taken in high school was 4 (Table II), which may assume that high school students should have approximately this number of science courses. Stavick (32) said the differences in the students achievement in course may depend upon the students' academic background. The students' academic background is different due to the variety programs the students had in high school. The science programs that were offered to some students may not have been offered to others. If high schools could offer a variety of courses in the several areas of science, it would provide each student with the basic concepts and principles of science and prepare them for further study at the college level.

The attitude of the subjects towards science showed a significant relationship to biology achievement. The mean of the attitude towards science scores of the subjects was 112.29 (Table II) revealing a positive attitude. This result indicates that nonscience students realize the significance and the usefulness of science as well as the science majors.

The number of high school science courses did not affect the attitude towards science in nonscience students in this study. There may be other factors that influence the attitude towards science such as the appropriate curricula, teacher's attitude, family background, and others. There should be a further study to investigate other possible factors that may affect the attitude towards science.

Recommendations for Further Research

The following recommendations are made for further research in this area.

1. The results of this study revealed that there was no sig-

nificant relationship between the number of high school science courses and the attitude towards science of nonscience college students. Research should be conducted to reconsider the relationship between these two variables. The subjects for the study should come from a variety of areas of science such as biology, chemistry, physics, and geology.

2. Research is needed to investigate if the previous experience, personality and academic preparation of the high school teacher (1) makes a difference in biology achievement of college students, and (2) influences the attitude towards science of college students.

3. Research should be conducted to determine if non-intellective factors such as motivation, conception or student's personality affect biology achievement of college students.

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APPENDIX A

AN INFORMATION SHEET

AN INFORMATION SHEET

Your Student I.D. Number ______________________________________

Your Classification ________FR ________SOPH ________JR ________SR

Please indicate below the number of semester of coursework you have had in the following:

	High School	College
BIOLOGY	______	______
CHEMISTRY	______	______
PHYSICS	______	______
EARTH SCIENCE	______	______
GENERAL SCIENCE	______	______
OTHER SCIENCE COURSES	______	______

APPENDIX B

NUMBER OF HIGH SCHOOL SCIENCE COURSES, NUMBER
OF COLLEGE SCIENCE COURSES, BIOLOGY
SCORES, AND ATTITUDE TOWARDS
SCIENCE SCORES OF
EACH STUDENT

Student	Number of High School Science Courses	Number of College Science Courses	Biology Scores	Attitude Scores
1	2	-	42	115
2	3	2	8	93
3	4	-	34	100
4	6	5	50	105
5	4	1	23	103
6	4	-	20	103
7	2	1	32	111
8	4	2	35	134
9	4	4	28	126
10	2	3	33	134
11	4	2	34	120
12	10	9	52	111
13	2	1	35	106
14	8	2	31	127
15	4	2	46	108
16	4	3	38	101
17	2	3	31	115
18	2	-	40	119
19	4	2	42	127
20	4	1	16	89
21	2	1	7	98
22	10	2	40	113
23	6	2	33	111
24	6	2	43	125
25	3	9	47	140
26	4	1	27	119
27	4	1	43	104
28	4	6	28	126
29	8	2	46	111
30	12	8	42	115
31	6	1	28	126
32	2	-	33	97
33	2	3	24	100
34	2	1	18	111
35	4	3	40	136
36	3	3	39	122
37	2	4	29	141
38	4	2	26	107
39	4	1	29	95
40	4	-	37	110
41	6	4	35	121
42	4	6	36	114
43	2	1	37	127
44	4	1	28	124
45	2	1	24	108
46	10	4	38	135
47	1	-	24	104
48	2	1	19	114
49	4	3	49	124
50	2	-	26	113

Student	Number of High School Science Courses	Number of College Science Courses	Biology Scores	Attitude Scores
51	2	-	28	112
52	4	-	31	123
53	6	-	52	119
54	4	1	31	118
55	2	1	39	99
56	4	1	43	106
57	4	-	36	119
58	2	-	46	124
59	4	1	34	109
60	7	1	30	93
61	1	-	19	115
62	6	-	28	120
63	6	-	31	109
64	2	-	27	97
65	4	2	26	107
66	4	-	39	127
67	4	1	42	118
68	4	-	37	106
69	2	1	34	107
70	2	1	19	117
71	6	-	47	115
72	6	2	30	116
73	8	-	27	103
74	4	1	43	113
75	4	1	13	91
76	4	1	47	111
77	2	2	34	128
78	6	-	14	91
79	2	-	17	104
80	3	1	37	106
81	4	-	27	99
82	6	2	54	95
83	2	-	37	123
84	2	-	31	101
85	4	1	30	136
86	4	2	16	105
87	1	2	26	96
88	10	-	45	126
89	4	2	44	103
90	4	-	34	107
91	6	1	18	129
92	4	-	25	103
93	3	-	26	105
94	3	-	25	109
95	4	2	34	119
96	6	-	24	103
97	3	-	39	123
98	2	2	26	78
99	4	-	24	78

Student	Number of High School Science Courses	Number of College Science Courses	Biology Scores	Attitude Scores
100	6	-	50	131
101	4	-	26	103
102	1	-	17	135
103	2	1	32	117
104	6	1	34	114
105	6	1	46	111
106	6	-	32	106
107	4	-	14	85
108	6	-	44	100
109	1	-	24	118
110	3	4	25	127
111	2	-	18	108
112	2	-	25	133
113	2	-	29	114
114	2	-	24	100

APPENDIX C

THE NELSON BIOLOGY TEST, FORM E

DIRECTIONS TO STUDENTS

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

In this test, each question has four suggested answers. Read each question carefully and decide which of the answers is best. Then write the letter of the answer you have chosen in the bracket at the left of the question. You may choose the answer that seems correct even if you are not perfectly sure, but you should not make wild guesses. If you cannot decide on the correct answer, write (DK) for "Don't Know." Erase completely any answer you wish to change. Study the sample questions below and notice how the correct answers have been written in the brackets.

SAMPLE A

( ) A robin is a kind of--
- (a) plant
- (b) worm
- (c) bird
- (d) fish
- (DK)

SAMPLE B

( ) Which of the following is not part of the human body?
- (e) heart
- (f) liver
- (g) kidney
- (h) antenna
- (DK)

You will have 40 minutes to answer 65 questions. Try to answer every question, but do not spend too much time on any one question. Do any necessary figuring right in the test booklet.

NELSON BIOLOGY TEST, FORM E

( ) 1 Characteristics of both plants and animals are found in--
(a) lichens
(b) liverworts
(c) euglena
(d) horsetails
(DK)

( ) 2 In a balanced aquarium oxygen is provided by--
(e) snails
(f) green plants
(g) sunlight
(h) water
(DK)

( ) 3 Which one of the following diseases might an individual contract from the food he has eaten?
(a) typhus fever
(b) anemia
(c) diabetes
(d) trichinosis
(DK)

( ) 4 The balance of nature has been most seriously disturbed by--
(e) carnivorous animals
(f) civilized man
(g) insects
(h) bacteria and fungi
(DK)

( ) 5 Which one of the following constitutes a food chain?
(a) milkweed-plant lice-spider-small bird-hawk
(b) grasshopper-wheat plant-mole-horse-whale
(c) mouse-rabbit-flea-woodchuck-snake
(d) corn-muskrat-bear-lion-deer
(DK)

( ) 6 The presence of certain apparently useless structures in man's body, such as the appendix and the muscles in the outer ears, may be an indication that--
(e) man had remote ancestors who used these strudtures
(f) man has always been as he is today
(g) man can regenerate organs at will
(h) these structures have helped man to survive
(DK)

( ) 7 Which of the following is an example of sexual reproduction?
(a) A mature paramecium divides into two offspring.
(b) A gardener plants pieces of potatoes containing "eyes" and later harvests a crop of potatoes.
(c) A fern plant produces many brown spores on the underside of the leaves. These spores give rise to young plants.

(d) A fish-hatchery worker pours some salmon milt into a jar of salmon eggs which later hatch into young salmon.
(DK)

( ) 8 One of the most marked differences between animal cells and plant cells is that--
(e) plant cells have chromosomes
(f) animal cells ordinarily have a nucleus
(g) plant cells usually have thick, rigid walls
(h) animal cells contain protoplasm
(DK)

( ) 9 Which one of the following is an example of a flowering plant?
(a) fern
(b) moss
(c) lichen
(d) corn
(DK)

( ) 10 One of the most important functions served by root hairs is to--
(e) increase the plant's sensitivity to stimuli
(f) increase the root's total absorbing surface
(g) enable roots to penetrate deeper into soil
(h) increase the total food storage capacity of the root
(DK)

( ) 11 A young man on an African safari was suddenly chased by a rhinoceros. He barely got into his truck when the rhino punched a hole in the side of the truck with the horn on its snout. The man's escape to cover was accelerated by a sudden secretion from which gland(s)?
(a) pituitary
(b) thyroid
(c) islets of the pancreas
(d) adrenal
(DK)

For questions 12 through 16, read carefully the following account of the science methodology used by Pasteur in studying chicken cholera.

Pasteur, while studying chicken cholera, happened to inoculate some laboratory hens with an old culture of the disease rather than with the fresh material he ordinarily used. Instead of dying, as other chickens had when inoculated with a culture of cholera microbes, these hens became ill and then recovered. Some time later he re-inoculated these hens (which we will call Group A) with a fresh cholera culture. He had expected them to die, as chickens usually did when inoculated with deadly cholera microbes. To his surprise, However, these hens remained perfectly healthy.

He then used some of this same fresh culture to inoculate another group of healthy chickens that had never before been inoculated. (We will call these hens Group B.) Within a few days all Group B chickens were either dead or dying. Meanwhile the Group A chickens, which had received the same kind of deadly cholera microbes in their second inoculation, were running about as usual, suffering no ill effects.

Now what could have happened to these hens in Group A, Pasteur wondered, that enabled them to withstand a second inoculation of deadly cholera germs without even getting sick? He went about for days pondering this question. Then an idea occurred to him. Perhaps the old weakened culture, used in the first inoculation of the Group A hens, had stimulated the chickens' own bodies to produce something in the blood stream that would fight off any similar germs which might later get into the blood stream. He would find out.

Classify each of the questions 12 through 16 according to the following KEY:

KEY
- (e) A problem that Pasteur would investigate.
- (f) A hypothesis suggesting a possible solution to the problem.
- (g) A constant factor--the same for both Group A and Group B.
- (h) The variable being tested--not the same for Group A and and Group B.
- (DK)

( ) 12 An inoculation of an old culture of cholera microbes was given to the Group A chickens.

( ) 13 What could have happened to the chickens in Group A that enabled them to withstand a second inoculation of deadly cholera germs without even getting sick?

( ) 14 An inoculation of fresh deadly cholera microbes was given to all of the chickens used in the experiment.

( ) 15 Perhaps the old weakened culture, used in the first inoculation of Group A chickens, had stimulated the chickens' own bodies to produce something in the blood stream that would fight off any similar germs which might later gain entrance into the body.

( ) 16 Pasteur used the same kind of experimental animal throughout this series of experiments.

Questions 17 through 19 are based on the illustration of the stages in the life cycle of a moss plant shown below. For each question select the best answer.

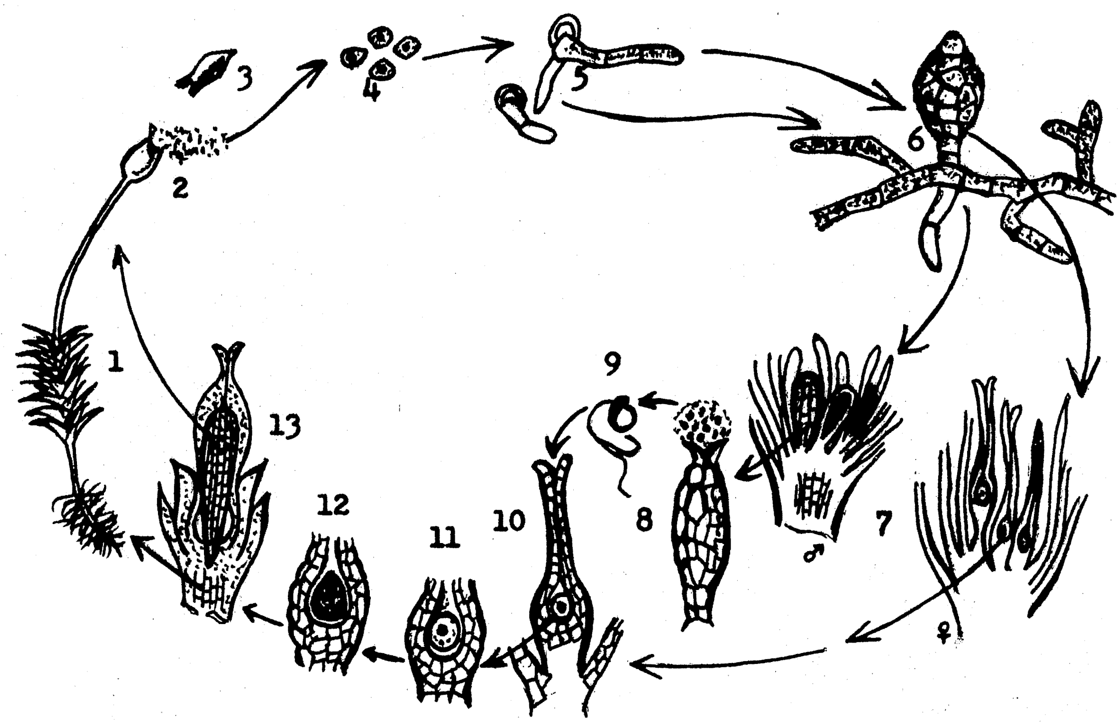

Diagram adapted from Pauli, Wolfgang G. <u>The World of Life: Student's Manual</u>. Boston: Houghton Mifflin Company, 1949, P. 19.

( ) 17 Which of the above represents the male gamete?
(a) 3 (b) 4 (c) 5 (d) 9 (DK)

( ) 18 Which of the above shows the 2n zygote?
(e) 6 (f) 11 (g) 10 (h) 8 (DK)

( ) 19 The n or haploid chromosome number occurs in all <u>except</u> which one of the above?
(a) 2 (b) 4 (c) 5 (d) 9 (DK)

( ) 20 The Mediterranean fruit fly has eight chromosomes in each of its body cells. The normal number of chromosomes in one of its mature sperm cells or egg cells would, therefore, be--
(e) two
(f) four
(g) eight
(h) sixteen
(DK)

( ) 21 In a food web, certain organisms are regarded as decomposers, some as producers, others as primary consumers, and still others as secondary consumers. Which of the following would be classified as a secondary consumer?
(a) deer
(b) wolf

(c) rabbit
(d) mouse
(DK)

( ) 22 A young plant vigorously growing near a window gradually bends toward the light because--
(e) the plant needs light to carry on photosynthesis
(f) the cells on the lighted side elongate faster than those on the shaded side
(g) the cells on the shaded side elongate faster than those on the lighted side
(h) stored radiant energy is being released as the plant grows
(DK)

( ) 23 The cabin of a long distance space ship could be made into a balanced biome by making provision for growing algae in it. During a flight of a year's duration, the algae could do all of the following <u>except</u>--
(a) supply food for passengers
(b) remove carbon dioxide from the interior of the space ship
(c) utilize body wastes from passengers
(d) carry on photosynthesis in the absence of light
(DK)

( ) 24 Two well-watered geranium plants, in sealed pots, were placed under two dry bell jars, X and Y. The leaves of the plant under Jar X were coated with vaseline on both upper and lower surfaces, while those of the plant under Jar Y were not coated. The two bell jars were then placed in bright sunlight for 8 hours. At the end of this time, what was the probable condition of the inside surface of the bell jars?
(e) Jar X showed more moisture than Jar Y.
(f) Jar X showed less moisture than Jar Y.
(g) Each jar was very moist with no noticeable difference in amount.
(h) Jar X was covered with many fine droplets of vaseline.
(DK)

( ) 25 Blood flowing through the pulmonary veins is distinguished from blood flowing through the jugular vein in the neck region in that the blood in the pulmonary veins--
(a) carries a fresh supply of oxygen
(b) carries antigens for blood type
(c) carries disease-resisting substances known as antibodies
(d) contains nutrient substances, such as sugar, fats, and amino acids
(DK)

( ) 26 All of the following secrete hormones <u>except</u> the--
(e) pituitary gland
(f) islets of the pancreas
(g) adrenal glands
(h) salivary glands
(DK)

( ) 27 The scientific name of the leopard frog is Rana pipiens, and that of the bullfrog is Rana catesbiana. These scientific names designate the frogs'--
(a) genus and species
(b) family and species
(c) class and genus
(d) phylum and order
(DK)

( ) 28 Bearing in mind the conditions necessary for photosynthesis to occur, it should be possible to produce a marked increase in plant growth in a closed greenhouse room by--
(e) drying the air in the room with a calcium chloride apparatus
(f) uncapping a bottle containing a chlorophyll solution and allowing its vapors to pass into the air in the room
(g) slowly releasing a continuous supply of carbon dioxide into the room from a carbon dioxide tank
(h) slowly releasing a continuous supply of pure oxygen into the room from an oxygen tank
(DK)

( ) 29 Scientists are in the process of cracking the most remarkable code on earth, namely, the code that determines the hereditary nature of every living organism. The specific carrier of this code is--
(a) Bowman's capsule
(b) deoxyribonucleic acid
(c) follicle stimulating hormone
(d) Huntington's chorea
(DK)

For questions 30 through 36, read carefully the following discussion of the inheritance of blood type in man.

In man there are three genes for ABO blood type. They have the following characteristics:
Gene A is dominant to gene O.
Gene B is dominant to gene O.
Gene A and B are not dominant to each other.
Every individual inherits two, and only two, of these genes--one from his father and one from his mother. The gene combination that any person has is known as his genotype. The following genotypes are possible:
AA or AO - individual has type A blood
BB or BO - individual has type B blood
AB - individual has type AB blood
OO - individual has type O blood
Another gene, R, is responsible for the Rh factor in the blood. Gene R is dominant to its recessive allele, gene r. With respect to these genes the following genotypes are possible:
RR or Rr - individual has Rh positive blood
rr - individual has Rh negative blood

An individual who has two genes of a pair that are alike, such as RR or rr, is said to be homozygous for this trait. One who has unlike genes, such as Rr, is said to be heterozygous for the trait.

Consider the following description of blood type as found in a man and a woman. Then, on the basis of all information given, select the best answer for each of the questions 30 through 36.

A man is homozygous for blood type B and heterozygous for the Rh factor.
His mother belongs to blood group AB and is Rh negative.
This man marries a woman who belongs to blood group A and is Rh positive.
Her father is Rh negative, indicating that the woman carries one recessive gene for Rh.
Her father also belongs to blood group O.
Her mother belongs to blood group A and is Rh positive.

( ) 30 The genotype of the woman's mother is--
- (e) AARr
- (f) AaRR
- (g) AaRr
- (h) impossible to determine
- (DK)

( ) 31 The genotype of the woman's father is--
- (a) OOrr
- (b) OORR
- (c) AOrr
- (d) impossible to determine
- (DK)

( ) 32 With respect to ABO and Rh blood types, the woman could produce which of the following kinds of egg cells?
- (e) AR and Ar
- (f) AR, Ar and OR
- (g) AR, Ar, OR and Or
- (h) impossible to determine
- (DK)

( ) 33 The man's genotype is--
- (a) BBRr
- (b) BORR
- (c) BORr
- (d) impossible to determine
- (DK)

( ) 34 The woman's genotype is--
- (e) AARr
- (f) AORr
- (g) AOrr
- (h) impossible to determine
- (DK)

( ) 35 With respect to ABO and Rh blood types, the man could produce which of the following kinds of sperm cells?
(a) BR and Br
(b) BR, Br and OR
(c) BR, Br, OR, and Or
(d) impossible to determine
(DK)

( ) 36 The only blood groups to which the r children could belong would be--
(e) AB and O
(f) AB and A
(g) AB and B
(h) A and O
(DK)

( ) 37 The deer population could be most effectively increased by--
(a) reducing the number of forest fires, by reforestation and by providing cover for the deer
(b) setting up feeding stations and supplying food for the deer in winter
(c) enacting laws to protect all carnivorous animals
(d) cutting down forests and providing more pasture for grazing
(DK)

( ) 38 Which one of the following has a bony internal skeleton?
(e) crayfish
(f) grasshopper
(g) rattlesnake
(h) starfish
(DK)

( ) 39 Which of the conclusions below might logically follow from the statement:
"The evidence seems to show beyond question that our present species of plants have descended...from simpler and fewer species which formerly existed--back, to a single kind which throve in remotest antiquity."--Ganong
(a) The number of plant species is decreasing.
(b) Generally speaking, plants are becoming simpler.
(c) Ancient plants were more successful than modern plants.
(d) The number of plant species is increasing.
(DK)

( ) 40 The most significant consequence of meiosis is the--
(e) doubling of the number of chromosomes in each cell
(f) maintaining of the diploid chromosome number in each resulting cell
(g) production of sperm or egg cells that are haploid
(h) formation of the spindle within the dividing cell
(DK)

( ) 41 When a sip of water goes "down the wrong way," there has been improper functioning of the--
(a) larynx
(b) trachea
(c) pharynx
(d) epiglottis
(DK)

( ) 42 When a virus invades a cell, it may interfere with the host cell's metabolism by causing the cell to manufacture virus-type--
(e) proteins and nucleic acids
(f) fat molecules
(g) glucose molecules
(h) carbon dioxide and carbonic acid
(DK)

( ) 43 Certain migrating birds seem to arrive in a given locality along the route at the same time each autumn. Their arrival time is fairly constant from one year to the next. This suggests that some environmental factor which is rather constant in its annual recurrence may serve as the stimulus to start this particular species of birds migrating. Which one of the following <u>possible</u> stimuli would be fairly constant from year to year?
(a) date of the first killing frost
(b) date when the hours of darkness first exceed the hours of daylight
(c) date when the food supply runs out
(d) date when the vegetation changes to autumn coloration
(DK)

( ) 44 Consider the following two equations:

$$CO_2 + H_2O^* + \text{energy} \longrightarrow \text{glucose} + O_2^*$$

$$CO_2^* + H_2O + \text{energy} \longrightarrow \text{glucose} + O_2$$

(O_2 is ordinary oxygen, O^* is heavy oxygen, CO_2 is carbon dioxide and H_2O is water.)

These two equations provide evidence that--
(e) oxygen in the atmosphere very likely comes from the carbon dioxide molecules used by green plants in photosynthesis
(f) oxygen in glucose manufactured in photosynthesis comes from the water molecules
(g) many substances entering the photosynthesis reaction cannot be accounted for in the end products
(h) oxygen released to the atmosphere in photosynthesis probably comes from the water molecules entering into the photosynthesis equation
(DK)

( ) 45 It is sometimes desirable when seeding a new lawn in poor soil to mix a small amount of white clover seed with the grass seed because the clover--
- (a) tends to crowd out weeds
- (b) produces carbon dioxide
- (c) has root structures which harbor nitrogen-fixing bacteria
- (d) protects the young grass plants from injury until the turf is well established
- (DK)

For questions 46 through 49, read carefully the following account of two experiments designed to demonstrate changes in osmotic pressure due to movements of water molecules.

Water molecules will move through a cell from a region of lesser concentration to a region of greater concentration of dissolved substances. If the concentration is the same both inside and outside the cell, a state of osmotic equilibrium exists and water molecules will enter and leave the cell at the same rate. Consider the following experiments:

EXPERIMENT I. Several long strips of raw potato (shaped like "French fries") were placed in a beaker containing 200 cc. of cold distilled water. These were allowed to stand for a half hour, after which the potato strips were examined.

EXPERIMENT II. Several long strips of raw potato were placed in a beaker containing 200 cc. of saturated salt solution. These were also allowed to stand for a half hour, after which the potato strips were examined.

Classify each of the questions 46 through 49 according to the following KEY:

KEY
- (e) Occurred in or was related to Experiment I.
- (f) Occurred in or was related to Experiment II.
- (g) Occurred in or was related to <u>both</u> Experiment I and Experiment II.
- (h) Occurred in or was related to <u>neither</u> Experiment I nor Experiment II, though relevant to them.
- (DK)

( ) 46 Water molecules passed through the membranes surrounding the potato cells.

( ) 47 More water molecules passed out of the potato cells than entered these cells.

( ) 48 The concentration of fluids remained unchanged inside the cells.

( ) 49 More water molecules entered the potato cells than passed out of these cells.

( ) 50 Coal beds found in Antarctica tend to indicate that at some time in the past Antarctica--
(e) had numerous actively erupting volcanoes
(f) was completely submerged under water
(g) had a dense cover of semi-tropical vegetation
(h) has been the scene of radioactive transformation
(DK)

( ) 51 The pancreas functions as a part of--
(a) both the digestive system and the endocrine system
(b) the digestive system only
(c) the endocrine system only
(d) neither the digestive nor the endocrine system
(DK)

( ) 52 A person is able to maintain his balance when he sits, stands, or walks, primarily because of the functioning of the--
(e) medulla oblongata
(f) spinal cord
(g) solar plexus
(h) semicircular canals
(DK)

( ) 53 Which cell structure becomes one of the poles of the spindle during mitosis?
(a) mitochondrion
(b) centrosome
(c) golgi body
(d) ribosome
(DK)

( ) 54 What theory is being defended by the author of the following passage?
"So we may doubt whether, in cheese and timber, worms are generated or if beetles and wasps in cow dung, or if butterflies, shellfish, eels, and such life be procreated of putrefied matter. To question this is to question reason, sense, and experience. If he doubts this, let him go to Egypt, and there he will find the fields swarming with mice begot of the mud of the Nile, to the great calamity of the inhabitants."--Ross
(e) sexual reproduction
(f) biogenesis
(g) spontaneous generation
(h) regeneration
(DK)

( ) 55 Glucose is oxidized at a much lower temperature inside living cells than over a flame mainly because of the presence in living cells of--
(a) oxygen
(b) water
(c) carbon dioxide
(d) enzymes
(DK)

( ) 56 Which of the following is characteristic of every individual living organism on the earth?
(e) It has a nucleus in each cell.
(f) It uses oxygen from the atmosphere.
(g) It uses energy in carrying on its life processes.
(h) It can adapt to changes in environment.
(DK)

( ) 57 How should the <u>italicized</u> portion of the following statement be classified? "If chromosomes convey to the daughter cells all the capacities of the mother cell, then the chromosomes must be the agents of heredity."
(a) deduction
(b) generalization
(c) observation
(d) analogy
(DK)

( ) 58 The RNA molecule has the same bases as the DNA molecule except that uracil replaces thiamine and the RNA molecule has a single strand rather than a double helix. An RNA molecule would, therefore, be represented by which one of the following?
(e) C-G-A-T
(f) C-G-A-U
(g) C-U-A-T
(h) C-G-U-T
(DK)

For questions 59 through 62, select from the KEY below the name of the digestive organ whose structure or function is described in each question.

KEY
(a) pancreas
(b) liver
(c) small intestine
(d) large intestine
(DK)

( ) 59 Bile is manufactured in this organ

( ) 60 One of the functions of this organ is water conservation. As indigestible food residues pass slowly through this organ, water is absorbed and returned to the body tissues.

( ) 61 The interior absorbing surface of the walls of this organ is enormously increased by many tiny villi present in the inside wall surface.

( ) 62 This organ secretes a hormone that regulates the use of carbohydrates by the body. A deficiency of this hormone may be indicated by the presence of sugar in the urine.

Questions 63 through 65 involve a comparison of DNA and RNA molecules. Classify each question according to the following KEY:

KEY
- (e) Characteristic of DNA molecules only.
- (f) Characteristic of RNA molecules only.
- (g) Characteristic of <u>both</u> DNA and RNA.
- (h) Characteristic of <u>neither</u> DNA nor RNA.
- (DK)

( ) 63 Messenger service appears to be one of the functions.

( ) 64 The base guanine is present.

( ) 65 There is a double helix of sugar-phosphate groups.

STOP! GO BACK AND CHECK YOUR WORK

APPENDIX D

THE SCIENTIFIC ATTITUDE INVENTORY

WHAT IS YOUR ATTITUDE TOWARD SCIENCE?

(A Scientific Attitude Inventory)

There are some statements about science on the next few pages. Some statements are about the nature of science, some are about how scientists work. Some of these statements describe how you might feel about science. You may agree with some of the statements and you may disagree with others. That is exactly what you will be asked to do. By doing this, you will show your attitude toward science.

After you have carefully read a statement, decide whether or not you agree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree mildly or strongly. Then, find the number of that statement on the answer sheet, and blacken the space by the

1 if you agree strongly.

2 if you agree mildly.

3 if you disagree mildly.

4 if you disagree strongly.

Example:

00. I would like to have a lot of money.

00. 1 2 3 4

(The person who marked this example agrees strongly with the statement, "I would like to have a lot of money.")

Please respond to each statement and blacken only one space for each statement.

WHAT IS YOUR ATTITUDE TOWARD SCIENCE?

1. I would enjoy studying science and using this knowledge in some scientific field.

2. Anything we need to know can be found out through science.

3. Scientific explanation can be made only by scientists.

4. Once they have developed a good theory, scientists must stick together to prevent others from saying it is wrong.

5. It is useless to listen to a new idea unless everybody agrees with the idea.

6. Science may be described as being primarily an idea-generating activity.

7. Scientists are always interested in improving their explanations of natural events.

8. If one scientist says a theory is true, all other scientists will believe him.

9. Science is so difficult that only highly trained scientists can understand it.

10. A useful scientific theory may not be entirely correct, but it is the best idea scientists have been able to think up.

11. We can always get answers to our questions by asking a scientist.

12. There are some things which are known by science to be absolutely true.

13. Most people are not able to understand the work of science.

14. Today's electric appliances are examples of the really valuable products of science.

15. Scientists cannot always find the answers to their questions.

16. When something is explained well, there is no reason to look for another explanation.

17. Most people are able to understand the work of science.

18. A scientific theory is no better than the objective observations upon which it is based.

19. Scientists believe that they can find explanations for what they observe by looking at natural phenomena.

20. The day after day search for scientific knowledge would become boring for me.

21. Scientific work would be too hard for me.

22. Scientists discover laws which tell us exactly what is going on in nature.

23. Scientific ideas may be said to undergo a process of evolution in their development.

24. The value of science lies in its usefulness in solving practical problems.

25. When one asks questions in science, he gets information by observing natural phenomena.

26. A good scientist doesn't have any ideas he is not willing to change.

27. Looking at natural phenomena is a most important source of scientific information.

28. Public understanding of science is necessary because scientific research requires financial support through the government.

29. Some questions cannot be answered by science.

30. Rapid progress in science requires public support.

31. Scientists do not need public support, they can get along quite well without it.

32. A scientist must be imaginative in developing ideas which explain natural events.

33. The value of science lies in its theoretical products.

34. Ideas are one of the more important products of science.

35. I do not want to be a scientist because it takes too much education.

36. There is no need for the public to understand science in order for scientific progress to occur.

37. When a scientist is shown enough evidence that one of his ideas is a poor one, he should change his idea.

38. All one has to do to learn to work in a scientific manner is to study the writings of great scientists.

39. Before one can do anything in science, he must study the writings of the great scientists.

40. People need to understand the nature of science because it has such a great affect upon their lives.

41. A major purpose of science is to produce new drugs and save lives.

42. One of the most important jobs of a scientist is to report exactly what his sense tell him.

43. If a scientist cannot answer a question, all he has to do is to ask another scientist.

44. An important purpose of science is to help man to live longer.

45. I would enjoy working with other scientists in an effort to solve scientific problems.

46. Scientific laws cannot be changed.

47. Science is devoted to describing how things happen.

48. Every citizen should understand science because we are living in an age of science.

49. I may not make many great discoveries, but working in science would still be interesting to me.

50. A major purpose of science is to help man live more comfortably.

51. Scientists should not criticize each other's work.

52. His senses are one of the most important tools a scientist has.

53. Scientists believe that nothing is known to be true with absolute certainty.

54. Scientific laws have been proven beyond all possible doubt.

55. I would like to work in a scientific field.

56. A new theory may be accepted when it can be shown to explain things as well as another theory.

57. Scientists do not have enough time for their families or for fun.

58. The products of scientific work are mainly useful to scientists, they are not very useful to the average person.

59. Scientists have to study too much and I would not want to be one for this reason.

60. Working in a laboratory would be an interesting way to earn a living.

VITA

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