Thomas Raymond Koballa, A STUDY OF PRESERVICE ELEMENTARY TEACHER ATTITUDE TOWARD SCIENCE AS MEASURED IN THE BIOLOGY LABORATORY. (Under the direction of Charles R. Coble) Department of Science Education, April, 1978.

The purpose of this study was to determine if the introduction of "professionally related activities" into the biology laboratory would significantly affect the student's attitude toward science and biological achievement. This study attempted to answer the following questions.

1. Are there any significant differences in the measurable attitudes between students exposed to "professionally related activities" and those not exposed to similar activities?

2. Are there any significant differences in the biological achievement levels between students exposed to "professionally related activities" and those not exposed to similar activities?

3. Are there any significant differences in the measurable attitudes between students taught by the study investigator and those taught by another laboratory instructor?

The study group consisted of 41 students enrolled in Science 1261, Biological and Environmental Science Laboratory for Elementary Education Majors, during the fall semester of the 1977-78 academic year at East Carolina University. The general method and instruments employed in this study were:

Students were pre-tested in August and post-tested in December using the Shrigley's Scale for Measuring Science Attitude of Preservice Elementary Teachers III and the Nelson Biology Test,

Revised Edition.

Three null hypotheses were tested in this study. Statistical analysis yielded the following results.

1. Utilizing analysis of covariance (with the students' pre-test scores as the covariate), no significant differences could be found in biology achievement for students in the treatment and non-treatment groups.

2. Utilizing analysis of covariance (with the students' pre-test scores as the covariate), a significant difference in attitude toward science was recorded at the .05 level between the treatment and non-treatment groups.

3. Using the *t*-test, no significant differences in the measurable attitudes between students taught by the study investigator and those taught by another laboratory instructor were obtained.

# A STUDY OF PRESERVICE ELEMENTARY TEACHER ATTITUDE TOWARD SCIENCE AS MEASURED IN THE BIOLOGY LABORATORY

A Thesis

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by

Thomas R. Koballa

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TABLE OF CONTENTS

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LIST OF TABLES

# CHAPTER I

## NATURE AND SIGNIFICANCE OF THE STUDY

Interest in the development of positive attitudes toward science among those involved in elementary teacher preparation has grown considerably over the past several years. The reason for this concern is partially expressed by Washton (1971) in his study of 100 New York elementary teachers enrolled in a graduate course at Queens College. He found that of the 100 teachers tested, 63 possessed a knowledge of science equivalent to that of the average ninth grader. From his findings he implies that:

> Most elementary school teachers dislike science because they did not achieve high scores on tests in high school or college. They did not recall much of any science that they were taught when they were in the elementary grades. They felt that their elementary school teachers disliked science so it was contagious to dislike science. As a result, they were afraid to teach science to their pupils (p. 378).

In 1968, the National Science Teachers Association issued a Staff Report on Scientific Literacy. The report concluded that:

> (a) The attitudes which an individual has, influence to a considerable degree his learning of science and his use of science and his use of the scientific information.
>
> (b) The possession of favorable attitudes toward science

> is an important characteristic of a scientifically literate person (p. 30).

Many courses required in present teacher education programs have little value toward developing positive attitudes in prospective teachers according to Boulos (1970, p. 203). Boulos states, "Many academic courses [Anthropology, Biology, Chemistry, Physics, etc.] and some professional courses are of little meaning to the prospective teacher" (p. 203). He attributes this to the lack of pertinent classroom experiences.

Shrigley (1974) believes, "That unless the teacher is attracted toward science, all the content and all the teaching methods which he may have learned can well serve no good purpose whatever" (p. 243).

Indeed, the need for favorable attitude development is essential in the preservice training of elementary teachers, but the question is, what method can be employed to improve these attitudes? Shrigley (1974) answers this question in his statement:

> If we can agree that the need exists for a more positive attitude toward science on the part of elementary teachers and if we can assume that attitudes are not innate, but learned, we must also assume that a positive attitude toward science can be taught (p. 243).

Numerous studies have been undertaken in hopes of successfully improving the attitudes toward science of preservice elementary teachers. Many of these studies (Hughes, 1971; Shrigley, 1974; and Bratt, 1977) have been successful, showing positive gains in attitude.

Attitude investigations have been undertaken in many different classroom situations, none are any better suited for this type of investigation than the science laboratory. Wheatley (1975) states, "The laboratory has been an important part of science courses in high schools and colleges since before the beginning of this century and has taken on increasing importance in recent years" (p. 101).

Many authors (Thurber and Collette, 1967; Anderson, 1968; and Hurd, 1972) have expressed the opinion that a major objective of science instruction should be to teach students applications of the principles and concepts studied. Wheatley (1975) suggests that the science laboratory lends itself readily to this task (p. 101).

## Purpose of the Study

The central purpose of this study is to determine the relationship between the introduction of "professionally related activities" and the attitudes and achievement levels of students enrolled in Biological and Environmental Science Laboratory For Elementary Education Majors. Therefore, this study attempts to:

1. Determine if the science attitudes of students enrolled in Science 1261 can be significantly improved by the introduction of "professionally related activities";

2. Determine if the biology achievement of students enrolled in Science 1261 can be significantly improved by the introduction of "professionally related activities".

## Limitations and Basic Assumptions

This study was limited to an analysis of the data collected from 41 students enrolled in Science 1261 at East Carolina University during the fall semester of 1977. While the results are limited to this described population, they may be generalized to analogous populations. In addition, this study was based upon the following assumption.

> The instruments employed for measuring the attitude toward science and biology achievement of the students were assumed to be valid to the extent that they measured that which they purported to measure. A description of these instruments has been included in Chapter III.

## Definition of Terms

The terms which have special meaning with respect to this study are the following.

Attitude toward science can be defined as, "The positive or negative feelings, opinions, beliefs in and about, and appreciation which individuals have formed as a result of interacting directly or indirectly with various aspects of scientific enterprise, and which exert a direct influence on their behavior toward science" (Hasan and Victor, 1975, p. 247).

Professionally related activities refers to activities chosen by the author and judged by a faculty panel to be beneficial in helping students relate their laboratory studies to their future professional responsibilities to teach science to elementary age students.

Preservice elementary teachers are those persons pursuing teacher certification in the fields of special education, primary education (K-3), and intermediate education (4-7). Because of their similar needs in the area of science background, they are grouped together in the biological and environmental science course.

## Organization of the Study

A five-step process was involved in the organization of this study:

1. A review of the related literature;

2. Collection and review of "professionally related activities";

3. Implementation of appropriate methodological procedures for the collection of data;

4. Analysis and presentation of the data;

5. Presentation of the summary, conclusions and implications.

Chapter II includes: (a) a review of the preparation of prospective science teachers from the nineteenth through the twentieth century, (b) a review of the effectiveness of the biology laboratory in elementary teacher training, (c) a review of studies of preservice teachers' attitudes toward science.

Chapter III explains the design of the study, including the hypotheses to be tested, the population studied, the procedures for collecting data, and descriptions of the various measuring instruments in the study. Finally, the statistical methods used in the study to analyze the data are explained.

Chapter IV presents the tested hypotheses and the results of the statistical analyses.

Chapter V includes a summary of the study, conclusions inferred from analyses of the data and implications which appear relevant.

A bibliography, as well as appendices containing tables and activities used, are included at the end of the study.

# CHAPTER II

## REVIEW OF RELATED LITERATURE

The problem of preparing elementary teachers adequately in the field of science has paralleled the development of education in America.

Many educators of the nineteenth century realized that the improvement of science curriculum resulted in no beneficial effect on the school programs if the teachers lacked the proper preparation to teach the material. This aspect of proper preparation was voiced in 1895 by Colonel Francis W. Parker:

> But it must be constantly borne in mind that foisting upon the schools of studies, no matter how strong the argument is concerning their intrinstic value, has been, and always will be, without the educated, trained and competent teacher. . . . before science studies can be used as a potent means of education, the trained teacher is an imperative necessity (p. 22).

In 1927, Alice Van de Voort reported in a curriculum investigation of courses in science offered in a large number of teacher training institutions, that science teachers were not adequately being prepared. She also indicated in her study that teachers' colleges were moving to change their curriculum by adding instructional methods courses and by providing instructional aids that could be used by prospective teachers upon entering the schools (p. 72).

When the National Society for the Study of Education published its Thirty-First Yearbook in 1932, it reported two possible reasons for the inadequacies of teacher preparation, (a) that teachers' colleges were requiring technical courses of study that had little value to the prospective teacher; and (b) that teachers' colleges were not teaching the prospective teachers various methods of relaying the essential information to their students" (p. 316).

W. C. Croxton, in his book Science In The Elementary School published in 1937, takes a stand along side many other educators with his criticism of the science preparation of teachers:

> This lack of acquaintance with the materials that teachers must utilize is an important limiting factor. The additional effort necessary to carry on a purposeful science activity program without an adequate background of training is only one of the handicaps that this lack entails. Perhaps even more important is the feeling of strangeness and helplessness which deters so many teachers from launching forth on a new venture. Rather than expose our inadequacies, we tend to shy away from situations that would be likely to involve and display them. It is doubtful whether anyone except the teacher herself, the science supervisor and the instructor in the teaching of science is fully aware of how little the average elementary teacher knows about her environment (p. 32).

Victor's study of elementary school teachers in 1962 reveals that the lack of familiarity with science content and the materials and the probable loss of professional prestige from inadequate preparation in science may contribute to a reluctance to teach science. He also found that when science was taught the teachers seemed unfamiliar with the objectives of science education and stressed the technological aspects of science rather than underlying principles and philosophy.

In their article, "Elements of Successful Inservice Education", Hone and Carswell (1969) stated that, "Children's built-in radar is fine-tuned to their teachers feelings about science" (p. 24). They feel that an attitude change on the part of elementary school teachers toward science is the primary goal of science education (Hone and Carswell, 1969, p. 24).

Importance of Teacher Attitude In Effective Science Teaching

Thomas H. Fisher (1973) states that, "The attitude of the student toward science is of greater importance than the knowledge of scientific fact" (p. 647).

The American Association for the Advancement of Science (1970) recommends that the education of preservice elementary teachers "should develop in teachers an appreciation for the historical, philosophical, and current significance of science to society, and positive attitudes about science" (p. 14).

H. Bentley Glass (1967) reiterates what many others have agreed upon, that attitude development should also be included as a goal of science teaching:

> It is indispensable to young scientists and nonscientists alike . . . to everyone who hopes to participate intelligently

> in the life of a scientific age which so constantly demands difficult decisions and real wisdom. . . . to know what science really is--to recognize its spirit and to appreciate its methods (p. 19).

A major concern of developing positive attitudes toward science is expressed by Dail (1976) in his statement:

> The concurrent themes which appear to reverberate in the literature are that science teaching should include . . . attitude instruction as well as concept and principle instruction, but the unfortunate discovery is that many science educators while probably aware of the importance of attitude teaching are doing too little to foster the development of attitudes in students (p. 19).

Effective Changes in the Attitudes of Teachers

Strollberg (1969) emphasized the effect of teacher attitude on their pupils. He feels that teachers, who have a negative or neutral attitude toward science, can pass on this attitude to younger children (p. 63).

Baumel and Burger (1965) expressed the same sentiments in saying, "The success in developing better attitudes toward science depends ultimately on the teacher" (p. 269).

Lindberg's study (1971) of Inservice Training of Science Teachers showed that attitudes toward science of elementary school teachers were greatly improved by active participation with living specimens in the classroom. As a result of the active participation, those teachers showed an increase in the time allotted for science during their regular school day. Lindberg implies from her study that, "Elementary teachers need more and better preparation to teach science in the elementary school" (p. 469).

Preservice Teachers' Attitudes Toward Science

In an attempt to upgrade the science teaching at the elementary level, the prospective teachers must be adequately prepared to teach factual aspects of science and also, by many (Fisher, 1973; Koran, 1969; Khrle, 1971, Shrigley, 1974; Weaver, 1978) believed to be the most important, to develop positive attitudes toward science in their pupils.

Shrigley (1974) states, "The development of a positive attitude toward science can be more beneficial in fostering a desire to know and understand science than all content and methods courses encountered by a prospective teacher" (p. 243).

The ambivilent attitudes of science now being expressed at the university have deep roots that extend as far back as the elementary education of the prospective teacher. Floyd Nordland and Alfred Devito (1974) have concluded from their studies that, "Freshman elementary education majors can be characterized as having a strong negative attitude toward science when they arrive at the university. The range of dissaffection runs from boredom and dislike to apprehension and fear" (p. 383).

Ehrle (1971) emphasizes the importance of properly educating the preservice teacher in science. He states:

> The time is long past when we can assume that attitudes will develop on their own accord out of the avalanche of 'new'

> knowledge we make available to our students. We must teach so that desired attitudes are openly and aggressively cultivated. Failure to do this turns a field of knowledge into a briar patch, a hostile environment for both teacher and student (p. 24).

In an attempt to develop positive attitudes toward science, Hughes (1971) tested the technique of role playing. According to Hughes:

> With the proceding evidence indicating that traditional science content classes or science methods classes do not produce the desired attitudes toward science in their students, an attitude change technique that could be utilized by college instructors of science content classes and science methods classes could be a valuable tool in teacher training (p. 114).

In his study, the sample was selected to obtain classes that had only elementary teacher candidates in the classroom in a setting which was selected to make an experimental treatment related to science and science teaching seem a natural extension of the normal class objectives. A persuasive communication and role playing technique was used to modify the attitudes of preservice elementary teachers toward science. The results indicated, by the use of a Likert-type rating scale, that the presentation of a persuasive communication and role playing technique to be an effective means of modifying the science attitudes of pre-service elementary teachers (Hughes, 1971, p. 114).

Bratt (1977), using the Bratt Attitude Test, found that a significant improvement in attitude toward science teaching and humanistic learning environments occurred when students were allowed to select and evaluate their daily activities (p. 215).

In a study of preservice elementary teachers at The Pennsylvania State University, Shrigley (1974) tested the correlation of science attitude to science knowledge. The assumptions of his study were:

(a) that attitudes of elementary age pupils toward science, affects their cognitive learnings in the subject;

(b) that pupil's attitudes toward science is affected by their teacher's attitude toward science; and

(c) that all attitudes of teachers toward science are affected by their knowledge of the subject (p. 144).

Shrigley hypothesized that:

A high positive correlation between science knowledge and science attitudes should result from a high cognitive level in science affected by the teacher's favorable attitude. If this is true, then by changing course objectives and concepts, the attitudes of teachers toward science could be improved (p. 144).

The results of the study indicated that a low positive correlation exists between science knowledge and attitude toward science on the part of preservice elementary teachers.

Shrigley's analysis of the results reveal that:

(a) A teacher's cognitive level in science does not necessarily affect his attitude toward the subject.

(b) Enrolling preservice elementary teachers in more college science courses will not necessarily result in a more positive attitude toward science.

(c) Teacher educators should explore other variables in addition to science knowledge as a means of improving the attitudes of preservice teachers toward science (p. 144-5).

According to Weaver (1978):

Science educators are stressing that the preservice preparation of elementary teachers in science education should include the development of positive attitudes toward science, acquisition of competence in the use of teaching strategies appropriate to investigatory type science, knowledge of the conceptual schemes and concepts of science, and an understanding of children and their learning processes for the purpose of structuring science activities (p. 2).

Effectiveness of the Biology Laboratory In Preservice Teacher Education

The biology laboratory readily lends itself as a place of experimentation of preservice elementary teachers (Syrocki, 1957; Dearden, 1962; Hacket and Holt, 1973; Chrouser, 1975; and Wheatley, 1975).

Syrocki (1957) attempted to formulate a list of criteria for the selection and development of laboratory experience units in general biology that could be used by college instructors of undergraduate biology courses for elementary education majors. He stated that, "There is a strong agreement among a select jury of elementary school teachers as to the importance of understanding certain principles of biology in order to teach them" (p. 313).

Hacket and Holt (1973) found that in the biology laboratory for non-science majors the employment of an audio-tutorial teaching method greatly improved the understanding of subject matter as opposed to traditional techniques (p. 499).

An outdoor versus indoor technique was tried by Chrouser (1975) in biology laboratories. His findings revealed, "A biology course for prospective elementary school teachers which emphasized field experience during much of the laboratory time is more effective in improving attitudes toward science than a course using only the indoor laboratory" (p. 48).

Wheatley (1975) attempted to show that higher levels of the cognitive domain can be successfully taught and evaluated in the biology laboratory. He concluded from his study that, "The performance of students at the higher cognitive levels can be increased by providing specially designed activities which allow students to actively manipulate data and evaluate hypotheses" (p. 109).

Although there have been a few studies using the biology laboratory as a vehicle of improving preservice elementary teachers' attitudes toward science, none have focused specificly on trying to relate their laboratory activities to their future professional needs.

# CHAPTER III

# DESIGN OF THE STUDY

This study was concerned with an analysis of attitudes and achievement level differences, as a result of the introduction of "profesionally related activites" to 41 students enrolled in Science 1261, Biological and Environmental Science Laboratory for Elementary Education Majors. The study, conducted during the fall semester of the 1977-78 academic year, was made possible through the cooperation of the department chairman, the course coordinator, and participation of laboratory instructors of the Science Education Department of East Carolina University.

## The Tested Hypothesis

Travers (1969) refers to hypotheses as, "statements of the consequences that can be expected of theory if it is true" (p. 12). "The null hypothesis is generally recognized as the best type of hypothesis to employ in statistical studies" (Coble, 1970, p. 63). The null hypothesis as defined by Batten (1976) is, "a method used to test the significance of differences. The hypothesis asserts that there is no true difference between the means of two distributions of scores, and that the difference found between sample means [if one] is accidental and unimportant" (p. 300). This provides a basis for accepting or rejecting the null hypothesis.

This study proposes to analyze two main hypotheses:

1. There are no significant differences in the measurable

attitudes between students exposed to "professionally related activities" and those that are not exposed to similar activities.

2. There are no significant differences in the biological achievement levels between students exposed to "professionally related activities" and those that are not exposed to similar activities.

In addition, this study examines one sub-hypothesis:

> There are no significant differences in the measurable attitudes between students taught by the study investigators and those taught by another laboratory instructor.

## Duration of the Study

This study was initiated in May, 1977, and terminated in December, 1977. Students were pre-tested for their attitudes toward science and for their level of biology achievement in August, 1977; post-test data related to study progress in the two variables were collected in December, 1977.

## The Study Group

The study group consisted of 41 students enrolled in Science 1261 (28 students were in the treatment group and 13 students were in the non-treatment group.) during the fall semester of the 1977-78 academic year at East Carolina University (see Appendix A, Table 4).

## Collection of the Data

The data used in this study were collected in two basic stages:

1. The author obtained the permission of the Chairman of the Science Education Department of East Carolina University and the course coordinator of Science 1261 to conduct the study.

2. Students in the four laboratory sections of Science 1261 were pre- and post-tested on the attitudes toward science and on their achievement in biology. Instruments used were the Shrigley's Scale for Measuring Science Attitude of Preservice Elementary Teachers III (1977) and the Nelson Biology Test, Revised Edition (1965).

Measurement of Study Progress

Growth in the student's attitude toward science and increased knowledge of science are two goals of science teaching. Therefore, measures of change in attitude toward science and of change in biology achievement were collected from the students participating in this study.

Attitude toward science

The test used to measure the variable of attitude toward science was Shrigley's Science Attitude Scale for Preservice Elementary Teachers III (see Appendix A). This test seemed to be the strongest one of its type available because of the selection of the sample used for standardization and the consequent modifications. Results from 35 students enrolled in a professional course dealing with the teaching of elementary school science at The Pennsylvania State University were tested in the winter of 1971 to establish standardization for the 23-item test, later modified.

The test used in this study was a 20-item Likert-type test consisting of 20 statements that are reacted to either positively or negatively. Scores on the test may range from 20 to 100. The reliability coefficient alpha for the Shrigley's Science Attitude Scale for Preservice Elementary Teachers III is reported as being around .90 (Shrigley, 1977, letter).

Students are asked to indicate their feelings toward the subject of science and the teaching of science in one of five ways: (a) strongly agree; (b) agree; (c) undecided; (d) disagree; or (e) strongly disagree. Shrigley's Science Attitude Scale for Preservice Elementary Teachers III was used for both pre-test and post-test. The entire test can be completed in about 15 minutes by college-age students. This test was administered in August and again in December, 1977.

Biology achievement

The instrument used to measure the variable of biology achievement was the Nelson Biology Test, Revised Edition. This test was constructed to measure "the extent to which important educational objectives have been attained by students in typical high school biology courses" (Nelson, 1966, p. 3).

The Nelson Biology Test was also applicable to this study because the population studied is composed mainly of entering freshmen, who until the end of their first semester, are a similar population to those used to standardize the test. Nelson limited the objectives of this test to three major cognitive categories--knowledge, comprehension, and application.

The revised version of the 1950 edition of the Nelson Biology Test includes items from the contemporary areas of cellular biology, biochemistry, and genetics. The test also includes items which attempt to reflect the changing curriculum emphasis brought about by the Biological Science Curriculum Study (BSCS). Included in the test are 65 items divided into four basic content areas as described by Nelson (1966):

1. Living Things (eighteen items). Measures a student's knowledge, understanding, and application of the (a) characteristics, (b) cellular and molecular structure, and (c) classification and grouping of living things.

2. Life Processes (thirty-four items). Measures a student's knowledge, understanding, and application of (a) human health and functions, (b) plant and animal life, and (c) life cycles, reproduction, heredity, and biological history.

3. Ecological Relationships (seven items). Measures a student's knowledge, understanding, and application of (a) the world biome, (b) natural resources, and (c) conservation.

4. Methodology and Research (six items). Measures a student's understanding and application of (a) experimental reasoning, (b) procedures, and (c) terminology (p. 3).

The Nelson Biology Test is designed to measure what is being taught in typical high school biology courses and in the case of this study what is being taught in a course designed for preservice elementary school teachers. Thus, studies of content validity provide the most appropriate estimate of the validity of this test. In relation to common accepted instructional emphasis, this test may be considered as having a high degree of validity. Reliability coefficients as high as +.92 are reported for high school students, based on split-half methods (Nelson, 1966, p. 13). A unique feature of this test is a guessing distractor or a "Don't Know" option for each item, which has the effect of reducing the amount of wild guessing. This test requires about 45 minutes to administer. Form E was used for both pre-test and post-test and was administered in August, 1977, and again in December, 1977.

## Procedure for Analysis of Data

Student data from Shrigley's Scale for Measuring Science Attitude of Preservice Elementary Teachers III and the Nelson Biology Test were hand calculated (see Appendix A).

### t-test

A *t*-test is used as a test of significance between the means of two groups and is significant if the value obtained is greater than the table value for the corresponding degrees of freedom at the desired level of significance. The table for determining the level of significance of *t*-values in this study was given in Table III of Schefler's text (1969, p. 214).

A *t*-test was used to determine if there were any significant differences in the measurable attitudes between students taught by the study investigator and those taught by another laboratory instructor.

### Analysis of covariance

In attempting to determine if a relationship could be established between differences in student attitude toward science and differences in biological achievement, it was not possible to randomly assign students into treatment and non-treatment groups due to complexities of class scheduling. This introduced into the study the uncontrolled variable of differences in initial attitude toward science and initial biological achievement held by the students being tested.

Differences in the attitude levels and levels of biological achievement were partially accounted for by using all students enrolled in Science 1261 fall semester, 1977. A statistical method was also used to control or adjust for the effects of the initial differences in student attitude toward science and biological achievement.

Where randomizing is not used, experiments may nevertheless be conducted using intact classes of students. In such cases, the hypotheses might be tested using a method called the analysis of covariance. This method, closely related to the analysis of variance, statistically equates classes on an initial measure (such as a pre-test of achievement or, in this study, entering attitudes). The initial variable is collected before the experimental treatment is begun. This approach can help reduce experimental error (Johnson, 1977, p. 238).

To justify the use of the analysis of covariance the correlation coefficient was calculated for the Nelson's Biology Test and Shrigley's Attitude Scale for Preservice Elementary Teachers III using the pre-test and post-test scores.

Correlation coefficient enables the researcher to study joint changes in two variables. It does this by (a) providing a single valued measure of the strength of the relationship between the two variables; (b) indicating the direction of the relationship (Johnson, 1977, p. 178). However, there should be a logical basis for pairing scores on the variables to be correlated.

An F-ratio was calculated for the analysis of covariance using the computational procedures described in Schefler's text (1969) and compared with the values in Table VII of the same text at the desired level of significance.

# CHAPTER IV

## ANALYSIS OF THE DATA

In order to analyze the effectiveness of the treatment exposure in this study, statements of the problem under investigation were presented in the form of null hypotheses. The investigator was directed in the collection of data appropriate to the problems by the statements of these hypotheses. There are two major and one subhypotheses tested in the study, all of which are discussed and summarized in this chapter.

### Hypothesis Concerning The Attitudes of Preservice Elementary School Teachers Toward Science

There were 41 students involved in the study; of these 92.7 percent were females and 7.3 percent were males. The Shrigley's Science Attitude Scale for Preservice Elementary Teachers III was administered prior to and upon completion of the testing period. It was used to test for differences in student attitude toward science between the treatment (N = 28) and non-treatment (N = 13) groups (see Appendix A, Table 4).

#### Hypothesis 1

There are no significant differences in the measurable attitudes between students exposed to "professionally related activities" and those that are not exposed to similar activities.

The mean differences between the pre-test scores and the post-test scores on Shrigley's Science Attitude Scale for Preservice Elementary Teachers III for the treatment and non-treatment groups are 5.36 and 1.07 respectively (see Appendix A, Table 4). The correlation coefficient as calculated for the Shrigley's test was .87, indicating a positive correlation between the pre-test and post-test scores (see Appendix A). This positive correlation between pre-test and post-test scores justified the investigator's use of the analysis of covariance.

An F-ratio of 6.84 means that there is a statistically significant difference in the measurable attitudes between students exposed to "professionally related activities" and those that are not exposed to similar activities (see Table 1). The hypothesis was rejected.

Hypothesis Concerning The Biological Achievement of Preservice Elementary Teachers

The same 41 students also took the Nelson Biology Test prior to and at the conclusion of the experiment. The Nelson Biology Test was used to test for differences in the biology achievement levels of students in the treatment (N = 28) and non-treatment (N = 13) groups.

The Nelson Biology Test Form E (1965) consists of 65 multiple choice questions divided into 4 content areas: (a) Living Things [18 items], (b) Life Processes [34 items], (c) Ecological Relationships [7 items], and (d) Methodology and Research [6 items] (Nelson, 1966, p. 3). This test,although standardized for high school students, is applicable because the population tested is similar to that used for standardization.

The mean difference between the pre-test and post-test scores on the Nelson Biology Test for the treatment and non-treatment groups are 12.82 and 10.00 respectively (see Appendix A, Table 4). The correlation coefficient as calculated for the Nelson Biology Test was .76, indicating a positive correlation between pre-test and post-test scores (see

TABLE 1

ANALYSIS OF COVARIANCE FOR SHRIGLEY'S ATTITUDE SCALE FOR PRESERVICE ELEMENTARY TEACHERS

| Source | SS | df | MS | F |
|---|---|---|---|---|
| Treatment | 157.77 | 1 | 157.77 | 6.84 |
| Within | 875.68 | 38 | 23.04 | |
| TOTAL | 1033.46 | | | |

$F_{(1.38)}\ .05 = 4.10$

Appendix A). This positive correlation between pre-test and post-test scores justifies the investigator's use of the analysis of covariance.

Hypothesis 2

There are no significant differences in biological achievement levels between students exposed to "profesionally related activities" and those that are not exposed to similar activities.

An F-ratio of 1.68 indicates that there are no significant differences in biological achievement levels between students exposed to "professionally related activities" and those that are not exposed to similar activities (see Table 2). The hypothesis was accepted.

Hypothesis Concerning Changes in the Science Attitude of Students as a Result of Experimental Bias

All researchers who attempt to prove a hypothesis have expectations as to the results of their experimentation. Wilson (1952) states, "The experimenter himself can easily be deceived in interpreting the results by his personal interest in the outcome" (p. 44). Conscious or unconscious expectations of the research that interfere in the outcome of an experiment are called biases (Wilson, 1952, p. 44).

As a result of the circumstances surrounding the study, it was necessary for the investigator to teach one treatment and one non-treatment section. In an attempt to show that the investigator introduced no bias that would considerably alter the outcome of the study, a hypothesis comparing the laboratory sections of both instructors was tested.

TABLE 2

ANALYSIS OF COVARIANCE FOR THE NELSON BIOLOGY TEST

| Source | SS | df | MS | F |
|---|---|---|---|---|
| Treatment | 76.22 | 1 | 76.22 | 1.68 |
| Within | 1116.74 | 38 | 45.17 | |
| TOTAL | 1792.96 | | | |

$F_{(1.38)}\ .05 = 4.10$

Hypothesis 3

There are no significant differences in the measurable attitudes between students taught by the study investigator (N = 18) and those taught by another laboratory instructor (N = 23).

The mean differences between the pre-test scores and the post-test scores for the study investigator and the other laboratory instructor are 5.33 and 3.83 respectively (see Appendix A, Table 5). A t-test value of 1.02 (see Appendix A) was calculated, indicating that there are no significant differences in the measurable attitudes between students taught by the study investigator and those taught by another laboratory instructor. The hypothesis was accepted.

Summary of Hypotheses

| Hypothesis | Analysis | Results |
| --- | --- | --- |
| 1. There are no significant differences in the measurable attitudes between students exposed to "profesionally realted activities" and those that are not exposed to similar activities. | Analysis of Covariance | Rejected |
| 2. There are no significant differences in the biological achievement levels between students exposed to "profess-ionally related activites" and those that are not exposed to similar activities. | Analysis of Covariance | Accepted |

| | | |
|---|---|---|
| 3. There are no significant differences in the measurable attitudes between students taught by the study investigator and those taught by another laboratory instructor. | *t*-test | Accepted |

## CHAPTER V

## SUMMARY, CONCLUSIONS AND IMPLICATIONS

One of the continuing concerns in science education has been and is the proper attitude preparation toward science among preservice elementary teachers. This concern develops from the elementary teachers who possess an unfavorable attitude toward science. As a result of these negative attitudes, the teacher neglects the teaching of science in the elementary classroom and also fosters poor attitudes toward science among the students.

Some previous researchers (Croxton, 1937; Victor, 1962) believe that more exposure to science by way of required courses and additional course work will improve the attitudes of preservice elementary teachers toward science.

This investigator and others (Shrigley, 1974; Strollberg, 1969; Weaver, 1978) believe that positive attitudes toward science can be acquired by the preservice teacher by various means. One being, the incorporating of activities into the regular curriculum that can be seen by the preservice teacher as being useful at a later date. However, none have focused specifically on trying to relate the laboratory activities of the preservice teachers to their future professional needs.

Recognizing that a positive attitude toward science among preservice elementary teachers is essential for good science teaching, this study attempted to answer the following questions:

1. Does the introduction of "professionally related activities" into the laboratory period significantly improve the attitudes toward

science of preservice teachers?

2. Does the introduction of "professionally related activities" into the laboratory period significantly improve the biological achievement of prospective teachers?

This study was concerned with answering these questions as they related to 41 students (28 in the treatment groups, 13 in the non-treatment group) enrolled in Science 1261 during fall semester, 1977.

The procedures followed in this study were (a) reviewing the literature related to science attitudes of prospective elementary teachers, biological achievement of prospective elementary teachers and the effectiveness of the biology laboratory in elementary teacher training, (b) collecting "professionally related activities" to be used in the laboratory, (c) designing the study, and (d) analyzing the data obtained from the design. The significant findings of the study, together with the implications related to the findings, are presented in this chapter.

Summary

Review of related literature

1. A considerable amount of research has been directed toward the task of improving elementary teacher attitudes toward science. One of the continuing difficulties in this area of research has been selecting the most effective means of improving attitudes toward science. At the present time, no one method has proven to be totally satisfactory.

2. Past studies attempt to relate attitude improvement among elementary teachers to required courses and additional course work.

3. Recent developments in science attitude improvement offer a new perspective from which to analyze the relationship between the attitudes of prospective teachers and the usefulness of the courses required in undergraduate training.

4. Shrigley (1974) developed a test for measuring the attitudes toward science of prospective elementary teachers. He hypothesized that, "A high positive correlation between science knowledge and science attitudes should result from a high cognitive level in science affected by the teachers favorable attitude" (p. 144).

5. Research directed toward testing the affects of teaching positive attitudes has been greatly facilitated by the development of the Shrigley's Science Attitude Scale for Preservice Elementary Teachers III.

6. Studies attempting to determine if a relationship exists between science attitude and biological achievement have all not been positive. However, from the studies reported to date, none have focused specifically on trying to relate the laboratory activities of prospective elementary teachers to their future professional needs.

Design of the study

7. This study involved 41 students enrolled in four sections of Science 1261 at East Carolina University.

8. All students in the four sections of Science 1261 were administered tests for measuring their attitude toward science and achievement in biology. These tests were given in August, 1977, and again in December, 1977, in order to measure the degree of student progress in these areas.

Analysis of the data

9. The *t*-test of significance was employed in order to determine if any significant differences could be detected between the laboratory sections taught by the study investigator and those sections taught by another laboratory instructor.

10. Analysis of covariance was used to determine if there were significant differences in the mean gains in science attitudes and biology achievement. The pre-test scores were used as the covariate in these analyses.

Conclusions

The results of this study indicate that the incorporation of "professionally related activities" into the regular laboratory period can successfully increase favorable attitudes toward science among preservice elementary teachers as illustrated by the significant changes between the treatment group and the non-treatment group. The changes were measured by the Shrigley's Science Attitude Scale for Preservice Elementary Teachers III.

The results further indicate that the incorporation of "professionally related activities" in no way hampers the biological achievement of the subjects, as measured by the Nelson Biology Test.

Also, the results indicate that no significant bias was introduced as a result of the investigator teaching one treatment and one non-treatment section of Science 1261.

Implications

The investigator anticipates that the results of this study hold implications to all areas of teacher preparation. Generally, the study implies that activities designed to improve science attitudes can be incorporated as a part of the instruction in a science laboratory.

Specifically, the study implies the following:

1. It is feasible to teach to develop favorable attitudes toward science among preservice elementary teachers.

2. Attitudes may be measured by instruments already available.

3. Attitude improvement is more likely with directed instruction than if it is left as an assumed result of a student merely being enrolled in a science course.

4. All science educators involved with the preparation of preservice elementary teachers need to become keenly aware of the role they play in the development of favorable attitudes toward science among their students.

5. More emphasis needs to be placed on future professional needs as a way of fostering favorable science attitudes among preservice elementary teachers.

6. More research effort and instructional developments need to be pursued in the area of teaching to improve science attitudes among preservice elementary teachers.

This investigator sees an ever-increasing need by science educators to develop favorable attitudes toward science among preservice elementary teachers, so they in turn can pass on to their students the vital basics of science, that are becoming increasingly necessary to exist in our ever-changing technological society.

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# APPENDIX A

# TABLES AND CALCULATIONS

TABLE 3

TREATMENT GROUP

| | Shrigley's Pre-test | Shrigley's Post-test | Difference | Nelson's Pre-test | Nelson's Post-test | Difference |
|---|---|---|---|---|---|---|
| 001 | 71 | 72 | 1 | 49 | 58 | 9 |
| 002 | 76 | 81 | 5 | 26 | 33 | 7 |
| 003 | 44 | 48 | 4 | 27 | 43 | 16 |
| 004 | 58 | 64 | 6 | 30 | 55 | 25 |
| 005 | 74 | 76 | 2 | 28 | 51 | 23 |
| 006 | 48 | 52 | 4 | 23 | 41 | 18 |
| 007 | 49 | 54 | 5 | 31 | 43 | 12 |
| 008 | 66 | 79 | 13 | 28 | 43 | 15 |
| 009 | 67 | 71 | 4 | 34 | 48 | 14 |
| 010 | 57 | 60 | 3 | 19 | 49 | 30 |
| 011 | 52 | 61 | 9 | 25 | 35 | 10 |
| 012 | 70 | 76 | 6 | 11 | 24 | 13 |
| 013 | 59 | 64 | 5 | 14 | 23 | 9 |
| 014 | 62 | 73 | 11 | 20 | 30 | 10 |
| 015 | 48 | 57 | 9 | 23 | 30 | 7 |
| 016 | 57 | 61 | 4 | 15 | 22 | 7 |
| 017 | 67 | 73 | 6 | 27 | 45 | 17 |
| 018 | 66 | 65 | -1 | 22 | 35 | 13 |
| 019 | 46 | 50 | 4 | 18 | 25 | 7 |
| 020 | 51 | 57 | 6 | 23 | 28 | 5 |
| 021 | 51 | 56 | 5 | 9 | 16 | 7 |
| 022 | 66 | 66 | 0 | 34 | 34 | 7 |
| 023 | 45 | 46 | 1 | 23 | 34 | 9 |
| 024 | 74 | 76 | 2 | 22 | 44 | 22 |
| 025 | 63 | 73 | 10 | 26 | 32 | 6 |
| 026 | 70 | 82 | 12 | 25 | 47 | 22 |
| 027 | 66 | 74 | 8 | 29 | 38 | 9 |
| 028 | 58 | 64 | 6 | 14 | 21 | 7 |
| $\overline{X}$ | 58.96 | 64.32 | 5.36 | 24.11 | 36.93 | 12.82 |

TABLE 3 CONTINUED

NONTREATMENT GROUP

| | Shrigley's Pre-test | Shrigley's Post-test | Difference | Nelson's Pre-test | Nelson's Post-test | Difference |
|---|---|---|---|---|---|---|
| 029 | 78 | 66 | -12 | 33 | 38 | 5 |
| 030 | 75 | 79 | 4 | 30 | 34 | 4 |
| 031 | 60 | 70 | 10 | 22 | 44 | 22 |
| 032 | 60 | 64 | 4 | 23 | 32 | 9 |
| 033 | 54 | 55 | 1 | 30 | 37 | 7 |
| 034 | 83 | 88 | 5 | 31 | 51 | 20 |
| 035 | 62 | 56 | -6 | 22 | 35 | 13 |
| 036 | 74 | 77 | 3 | 22 | 19 | -2 |
| 037 | 49 | 50 | 1 | 26 | 37 | 11 |
| 038 | 67 | 73 | 6 | 31 | 43 | 12 |
| 039 | 60 | 64 | 4 | 20 | 31 | 11 |
| 040 | 60 | 52 | -8 | 13 | 18 | 5 |
| 041 | 74 | 76 | 2 | 26 | 40 | 14 |
| $\bar{X}$ | 65.85 | 66.92 | 1.07 | 25.31 | 35.31 | 10.00 |

TABLE 4

TAUGHT BY THE STUDY INVESTIGATOR

| Student | Shrigley's Pre-test | Shrigley's Post-test | Difference |
|---|---|---|---|
| 001 | 71 | 72 | 1 |
| 002 | 76 | 81 | 5 |
| 003 | 44 | 48 | 4 |
| 004 | 58 | 64 | 6 |
| 005 | 74 | 76 | 2 |
| 006 | 48 | 52 | 4 |
| 007 | 49 | 54 | 5 |
| 008 | 66 | 79 | 13 |
| 009 | 67 | 71 | 4 |
| 010 | 57 | 60 | 3 |
| 011 | 52 | 61 | 9 |
| 012 | 70 | 76 | 6 |
| 013 | 59 | 64 | 5 |
| 029 | 78 | 66 | -12 |
| 030 | 75 | 79 | 4 |
| 031 | 60 | 70 | 10 |
| 032 | 60 | 64 | 4 |
| 033 | 54 | 55 | 1 |
| $\overline{X}$ | | | 5.33 |

TABLE 4 CONTINUED

TAUGHT BY ANOTHER LABORATORY INSTRUCTOR

| Student | Shrigley's Pre-test | Shrigley's Post-test | Difference |
|---|---|---|---|
| 014 | 62 | 73 | 11 |
| 015 | 48 | 57 | 9 |
| 016 | 57 | 61 | 4 |
| 017 | 67 | 73 | 6 |
| 018 | 66 | 65 | -1 |
| 019 | 46 | 50 | 4 |
| 020 | 51 | 57 | 6 |
| 021 | 51 | 56 | 5 |
| 022 | 66 | 66 | 0 |
| 023 | 45 | 46 | 1 |
| 024 | 74 | 76 | 2 |
| 025 | 63 | 73 | 10 |
| 026 | 70 | 82 | 12 |
| 027 | 66 | 74 | 8 |
| 028 | 58 | 64 | 6 |
| 034 | 83 | 88 | 5 |
| 035 | 62 | 56 | -6 |
| 036 | 74 | 77 | 3 |
| 037 | 49 | 50 | 1 |
| 038 | 67 | 73 | 6 |
| 039 | 60 | 64 | 4 |
| 040 | 60 | 52 | -8 |
| 041 | 74 | 76 | 2 |
| $\overline{X}$ | | | 3.83 |

CALCULATION OF CORRELATION COEFFICIENT FOR

SHIRGLEY'S SCIENCE ATTITUDE SCALE FOR

PRESERVICE ELEMENTARY TEACHERS III

$\Sigma X = 2511$ $\Sigma X^2 = 157919$

$\Sigma Y = 2671$ $\Sigma Y^2 = 178499$

$\Sigma XY = 167365$ $N = 41$

$$r = \frac{\Sigma XY - \Sigma X \Sigma X/N}{\sqrt{[\Sigma X^2 - (\Sigma X)^2/N][\Sigma Y^2 - (\Sigma Y)^2/N]}}$$

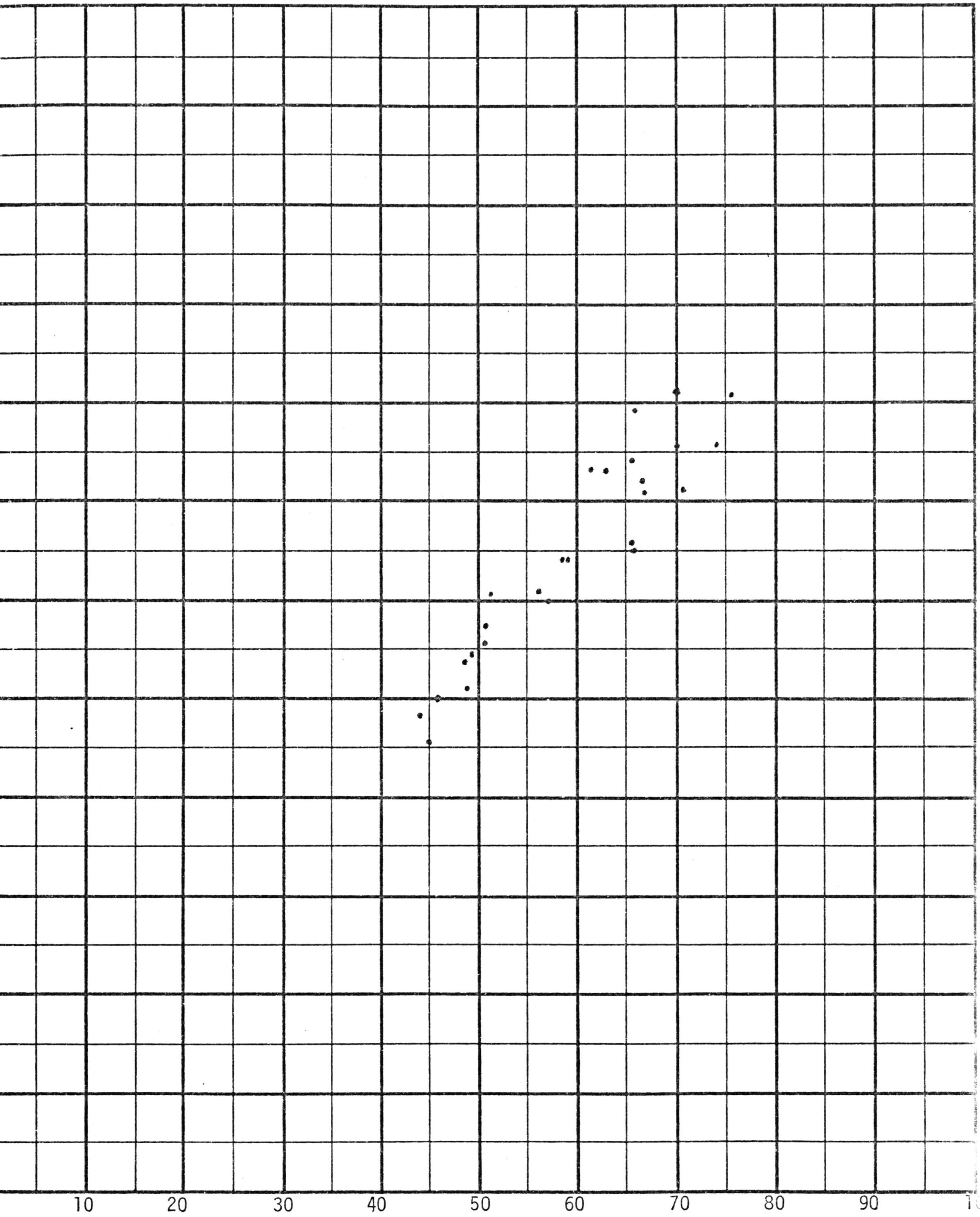
$$= \frac{167365 - (2511)(2671)/41}{\sqrt{[157919 - (2511)^2/41][178499 - (2671)^2/41]}}$$

$$= \frac{3782.537}{\sqrt{(4135.561)(4493.122)}}$$

$$= \frac{3782.537}{4310.636}$$

$$= .877$$

CORRELATION COEFFICIENT OF SHRIGLEY'S SCIENCE ATTITUDE SCALE



THE ANALYSIS OF COVARIANCE FOR SHRIGLEY'S SCIENCE ATTITUDE SCALE FOR PRESERVICE ELEMENTARY TEACHERS III

$\Sigma X = 2511$ | $\Sigma X_A = 1651$ | $N = 41$

$\Sigma Y = 2671$ | $\Sigma X_B = 860$ | $K_A = 28$

$\Sigma XY = 167365$ | $\Sigma Y_A = 1801$ | $K_B = 13$

$\Sigma X^2 = 157919$ | $\Sigma Y_B = 870$

$\Sigma Y^2 = 178499$

X - values (pre-test scores)

$$SS\ total = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= 157919 - \frac{(2511)^2}{41}$$

$$= 157919 - 153783.439$$

$$= 4135.561$$

$$SS\ treatment = \frac{(\Sigma X_A)^2}{K_A} + \frac{(\Sigma X_B)^2}{K_B} - \frac{(\Sigma X)^2}{N}$$

$$= \frac{(1651)^2}{28} + \frac{(86D)^2}{13} - \frac{(2511)^2}{41}$$

$$= 97350.036 + 56892.308 - 153783.439$$

$$= 458.905$$

$$SS\ within = SS\ total - SS\ treatment$$

$$= 4135.561 - 458.905$$

$$= 3676.656$$

Y - values (post-test scores)

$$SS\ total = \Sigma Y^2 - \frac{(\Sigma Y)^2}{N}$$

$$= 178499 - \frac{(2671)^2}{41}$$

$$= 178499 - 174005.878$$

$$= 4493.122$$

$$SS\ treatment = \frac{(\Sigma Y_A)^2}{K_A} + \frac{(\Sigma Y_B)^2}{K_B} - \frac{(\Sigma Y)^2}{N}$$

$$= \frac{(1801)^2}{28} + \frac{(870)^2}{13} - \frac{(2671)^2}{41}$$

$$= 155842.893 + 58223.077 - 174005.878$$

$$= 60.092$$

$$SS\ within = SS\ total - SS\ treatment$$

$$= 4493.122 - 60.092$$

$$= 4433.03$$

Cross Products

$$SS\ total = \Sigma XY - \frac{\Sigma X \Sigma Y}{N}$$

$$= 167365 - \frac{(2511)(2671)}{41}$$

$$= 167365 - 163582.463$$

$$= 3782.537$$

$$SS\ treatment = \frac{(\Sigma X_A)(\Sigma Y_A)}{K_A} + \frac{(\Sigma X_B)(\Sigma Y_B)}{K_B} - \frac{\Sigma X \Sigma Y}{N}$$

$$= \frac{(1651)(1801)}{28} + \frac{(860)(870)}{13} - \frac{(2511)(2671)}{41}$$

$$= 106194.679 + 57553.846 - 163582.463$$

$$= 166.062$$

SS within = SS total - SS treatment

= 3782.537 - 166.026

= 3616.511

| Source | SS(X) | SS(Y) | SS(XY) |
|---|---|---|---|
| Total | 4135.561 | 4493.122 | 3782.537 |
| Treatment | 458.905 | 60.092 | 166.026 |
| Within | 3676.656 | 4433.03 | 3616.511 |

Treatment

$$b = \frac{\Sigma XY}{\Sigma X^2}$$

$$= \frac{3782.537}{4135.561}$$

$$= .91464$$

$$\Sigma(Y - Y_1)^2 = \Sigma(Y - \overline{Y})^2 - b\Sigma XY$$

$$= 4493.122 - (.91464)(3782.537)$$

$$= 1033.462$$

Within

$$b = \frac{\Sigma XY}{\Sigma X^2}$$

$$= \frac{3616.511}{3676.656}$$

$$= .98364$$

$$\Sigma(Y - Y_2)^2 = \Sigma(Y - \overline{Y})^2 - b\Sigma XY$$

$$= 4433.03 - (.98364)(3616.511)$$

$$= 875.685$$

| Source | df | SS | MS |
|---|---|---|---|
| Treatment | 1 | 157.77 | 157.77 |
| Within | 38 | 875.68 | 23.04 |
| Total | | 1033.46 | |

$$F = \frac{\text{Mean Square Treatment}}{\text{Mean Square Within}}$$

$$= \frac{157.777}{23.044}$$

$$= 6.847^{*}$$

$^{*}F_{1,38}\ .05 = 4.10$

CALCULATION OF CORRELATION COEFFICIENT

FOR THE NELSON BIOLOGY TEST, FORM E (1965)

$\Sigma X = 1004$ $\Sigma X^2 = 26744$

$\Sigma Y = 1493$ $\Sigma Y^2 = 58651$

$\Sigma XY = 38879$ $N = 41$

$$r = \frac{\Sigma XY - \Sigma X \Sigma Y/N}{\sqrt{[\Sigma X^2 - (\Sigma X)^2/N][\Sigma Y^2 - (\Sigma Y)^2/N]}}$$

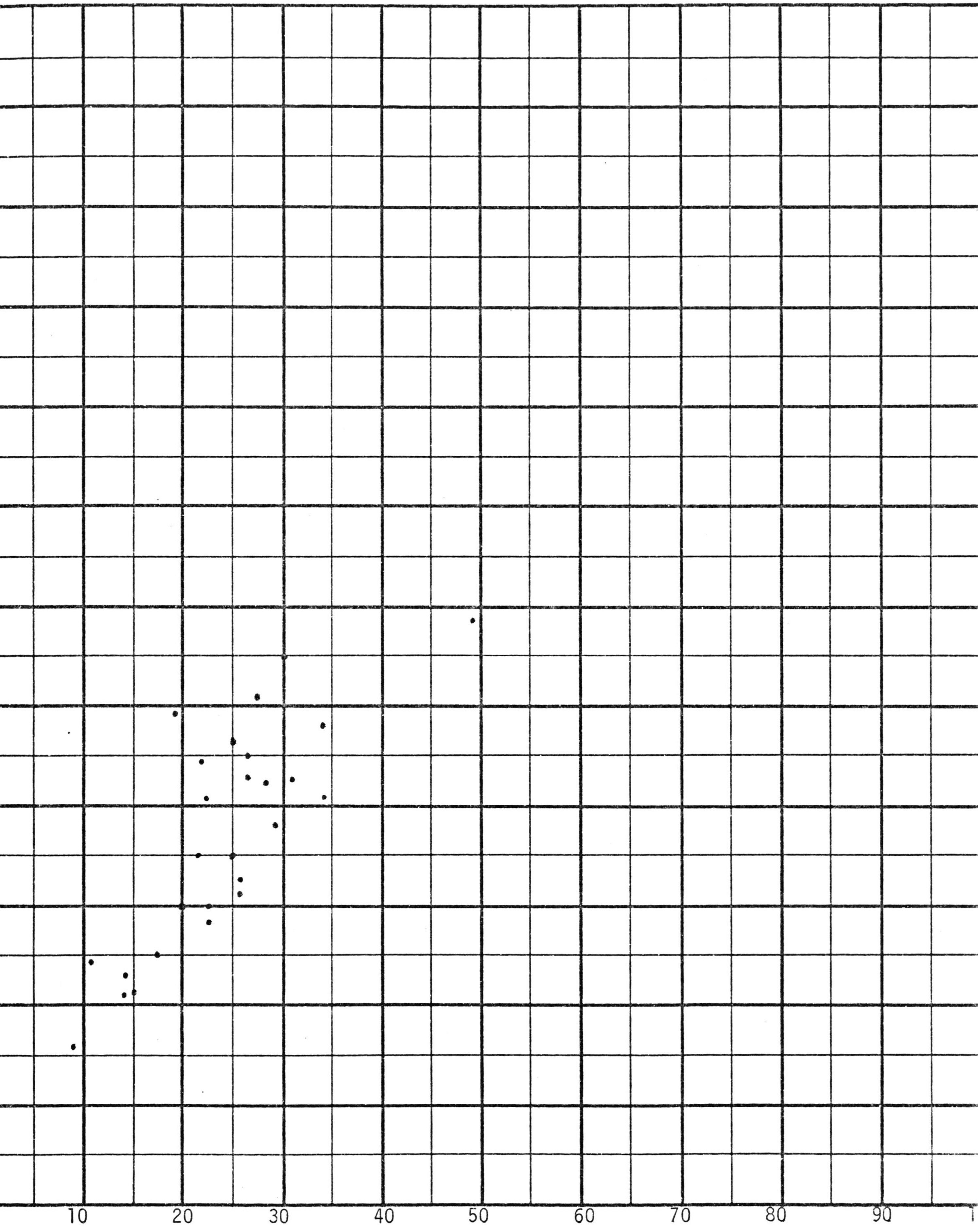
$$= \frac{38879 - (1004)(1493)/41}{\sqrt{[26744 - (1044)^2/41][58651 - (1493)^2/41]}}$$

$$= \frac{2318.707}{\sqrt{(2158.244)(4283.951)}}$$

$$= \frac{2318.707}{3040.695}$$

$$= .762$$

CORRELATION COEFFICIENT OF THE NELSON BIOLOGY TEST



THE ANALYSIS OF COVARIANCE FOR THE NELSON BIOLOGY TEST, FORM E (1965)

$\Sigma X = 1004$ | $\Sigma X_A = 675$ | $N = 41$

$\Sigma Y = 1493$ | $\Sigma X_B = 329$ | $K_A = 28$

$\Sigma XY = 38879$ | $\Sigma Y_A = 1034$ | $K_B = 13$

$\Sigma X^2 = 26744$ | $\Sigma Y_B = 459$

$\Sigma Y^2 = 58651$

X - values (pre-test scores)

$$SS\ total = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= 26744 - \frac{(1044)^2}{41}$$

$$= 2158.244$$

$$SS\ treatment = \frac{(\Sigma X_A)^2}{K_A} + \frac{(\Sigma X_B)^2}{K_B} - \frac{(\Sigma X)^2}{N}$$

$$= \frac{(675)^2}{28} + \frac{(329)^2}{13} - \frac{(1044)^2}{41}$$

$$= 16272.321 + 8326.231 - 24585.756$$

$$= 12.796$$

$$SS\ within = SS\ total - SS\ treatment$$

$$= 2158.244 - 12.796$$

$$= 2145.448$$

Y - values (post-test scores)

$$SS\ total = \Sigma Y^2 - \frac{(\Sigma Y)^2}{N}$$

$$= 58651 - \frac{(1493)^2}{41}$$

$$= 4283.951$$

$$\text{SS treatment} = \frac{(\Sigma Y_A)^2}{K_A} + \frac{(\Sigma Y_B)^2}{K_B} - \frac{(\Sigma Y)^2}{N}$$

$$= \frac{(1034)^2}{28} + \frac{(459)^2}{13} - \frac{(1493)^2}{41}$$

$$= 38183.143 + 16206.231 - 54367.049$$

$$= 23.325$$

$$\text{SS within} = \text{SS total} - \text{SS treatment}$$

$$= 4283.951 - 23.325$$

$$= 4260.626$$

Cross Products

$$\text{SS total} = \Sigma XY - \frac{\Sigma X \Sigma Y}{N}$$

$$= 38879 - \frac{(1004)(1493)}{41}$$

$$= 2318.707$$

$$\text{SS treatment} = \frac{(\Sigma X_A)(\Sigma Y_A)}{K_A} + \frac{(\Sigma X_B)(\Sigma Y_B)}{K_B} - \frac{\Sigma X \Sigma Y}{N}$$

$$= \frac{(675)(1034)}{28} + \frac{(329)(459)}{13} - \frac{(1004)(1493)}{41}$$

$$= 24926.786 + 11616.231 - 36560.293$$

$$= 17.276$$

| Source | SS(X) | SS(Y) | SS(XY) |
|---|---|---|---|
| Total | 2158.244 | 4283.951 | 2318.707 |
| Treatment | 12.796 | 23.325 | -17.276 |
| Within | 2145.448 | 4260.626 | 2335.983 |

Treatment

$$b = \frac{\Sigma XY}{\Sigma X^2}$$

$$= \frac{2318.707}{2158.244}$$

$$= 1.8743$$

$$\Sigma(Y - Y_1)_2 = \Sigma(Y - \overline{Y})^2 - b\Sigma XY$$

$$= 4283.951 - (1\ 0743)(2318.707)$$

$$= 1792.964$$

Within

$$b = \frac{\Sigma XY}{\Sigma X^2}$$

$$= \frac{2335.983}{2145.448}$$

$$= 1.089$$

$$\Sigma(Y - Y_1)^2 = \Sigma(Y - \overline{Y})^2 - b\Sigma XY$$

$$= 4260.626 - (1.089)(2335.983)$$

$$= 1716.741$$

| Source | df | SS | MS |
|---|---|---|---|
| Treatment | 1 | 76.22 | 76.22 |
| Within | 38 | 1716.74 | 45.17 |
| Total | | 1792.96 | |

$$F = \frac{MS\ (treatment)}{MS\ (within)}$$

$$= \frac{76.223}{45.177}$$

$$= {}^*1.687$$

$^*F_{(1,38)}\ .05 = 4.10$

# CALCULATION FOR t-TEST BETWEEN STUDY INVESTIGATOR AND ANOTHER LABORATORY INSTRUCTOR

X (study investigator)

$\overline{X} = 5.33$

$\Sigma(X - \overline{X}) = 354.54$

$N = 18$

Y (other

$\overline{Y} = 3.83$

$\Sigma(Y - \overline{Y}) = 495.25$

$N = 23$

$$Sp^2 = \frac{\Sigma(X - \overline{X})^2 + \Sigma(Y - \overline{Y})^2}{N_X + N_Y - 2}$$

$$= \frac{354.54 + 495.25}{18 + 23 - 2}$$

$$= \frac{849.79}{39}$$

$$= 21.79$$

$$S_{\overline{X} - \overline{Y}} = \sqrt{\frac{Sp^2}{N_X} + \frac{Sp^2}{N_Y}}$$

$$= \sqrt{\frac{21.79}{18} + \frac{21.79}{23}}$$

$$= \sqrt{1.211 + .947}$$

$$= 1.469$$

$$\underline{t} = \frac{\overline{X} - \overline{Y}}{S_{\overline{X} - \overline{Y}}}$$

$$= \frac{5.33 - 3.83}{1.469}$$

$$= 1.02^*$$

$$\underline{t}_{(40)}.10 = 1.303^*$$

# SCIENCE ATTITUDE SCALE FOR PRESERVICE ELEMENTARY TEACHERS III

(Modified 4-77) Robert L. Shrigley
The Pennsylvania State University
University Park, PA. 16802

Directions: This is not a test. You are to indicate your feelings toward the subject of science and the teaching of science. You may react to the statement in one of five ways:

| | Scoring | |
|---|---|---|
| | If Positive | If Negative |
| A - Strongly Agree | 5 points | 1 point |
| B - Agree | 4 | |
| C - Undecided | 3 | |
| D - Disagree | 2 | |
| E - Strongly Disagree | 1 | |

1. I daydream during science classes. (Neg.)
2. Science is an excellent minor in the program of education student preparing to teach children. (Pos.)
3. I dread science classes. (Neg.)
4. Science equipment confuses me. (Neg.)
5. I enjoy manipulating science equipment. (Pos.)
6. I fear that children will ask me science questions that I cannot answer. (Neg.)
7. In science classes, I enjoy lab periods. (Pos.)
8. Science is my favorite subject. (Pos.)
9. I would prefer teaching science over any other subject in the elementary school. (Pos.)
10. Science classes are boring. (Neg.)
11. I would enjoy helping children construct science equipment. (Pos.)
12. I fear that the science demonstrations will not work when I teach science to children. (Neg.)
13. I enjoy college science courses. (Pos.)
14. Science instructors should demonstrate equipment instead of expecting me to manipulate it. (Neg.)
15. I would enjoy working in an experimental elementary science curriculum project. (Pos.)
16. I enjoy discussing science topics with my friends. (Pos.)
17. Science is difficult for me to understand. (Neg.)
18. I expect to be able to excite children about science. (Pos.)
19. I enjoy using scientific ideas in my personal life. (Pos.)
20. I believe that I have the same curiosity as children. (Pos.)

References: Examine these articles for history and statistical data: "The Correlation of Science Attitude and Science Knowledge of Preservice Elementary Teachers", Science Education: 58(2) 143-151 (1974): "The Attitude of Preservice Elementary Teachers Toward Science", School Science and Mathematics, 74: 243-250 (March 1974). (The original scale was published in this issue.)

Note: The researcher will drop the (Neg.) and Pos.) designations, as well as the scoring information when preparing the scale for administration to subjects.

# APPENDIX B

## PROFESSIONALLY RELATED ACTIVITIES, DEMONSTRATIONS, AND DISCUSSION

# SCIENCE 1261 LABORATORY SCHEDULE
Fall Semester, 1977
Biological and Environmental Science

| Week | Laboratory Topic | Assignment |
|---|---|---|
| 1 | Identification of Minerals | Handout |
| 2 | Identification of Rocks | Handout |
| 3 | Map Skills | Handout |
| 4 | Environmental Factors | Handout |
| 5 | The Microscope, Diversity in Plants | No. 846, 615 |
| 6 | Diversity in Plants Continued | No. 617, 873, 874 |
| 7 | Cells and Their Organization | No. 602 |
| 8 | Physical and Chemical Aspects of Life | No. 605, 606 |
| 9 | Mid-Term | |
| 10 | Digestion and Respiration | No. 608, 609 |
| 11 | Biological Transport and Coordination | No. 610, 611 |
| 12 | Plant Anatomy and Development | No. 603, 614 |
| 13 | Final Exam | |

TEXT: Laboratory Outlines by Peter Abramoff and Robert Thomson.

# THE MICROSCOPE, DIVERSITY IN PLANTS - MYCOPHYTA

## Professionally Related Activities, Demonstrations, and Discussion

### Activities

1. Use of ESS "small things" microscopes.

2. Use of hand lens.

3. Use of eye glass lens.

4. Use of water drop microscope (Rosenbaum, 1970, p. 8).

5. Examine current elementary texts on display for magnification activities.

6. Examine pictures of objects taken under various powers of magnification.

7. "Bacteria Handshake". Observe the following week. (Morholt, Brandwein and Joseph; 1977; p. 449).

8. Detect foul odor associated with bacterial growth by smelling spoiled foods.

### Demonstrations

1. Image reversion and magnification, using olive jar filled with water. CODIOXIDE: reversion word.

2. Inoculate nutrient agar by touching coin, touching fingertip lightly, pour film of milk or film of pickle juice over agar. Observe the following week.

3. View slides of bacteria, algae-like fungi, yeasts and club fungi (Dr. Charles Bland, ECU Biology Department).

SCIENCE 1261
Supplemental Handout
Bacteria and Fungi

Bacteria, yeast and molds are called decomposers; they digest available food, such as a dead cricket, into a liquid that can be absorbed. As this process proceeds, we say that decomposition of the organism is taking place.

Bacteria

Obtain several sterile petri dishes containing nutrient agar medium. Inoculate in the following ways:

touch several coins

touch fingertip lightly

film of yogurt, milk, sauerkraut, pickle juice or water in which beans or peas are left to decay.

Sterilizing petri dishes and nutrient agar media should be done separately in a pressure cooker at $250^{0}$ F at 15 lbs. per sq. in. for 15 minutes.

Some organisms that die can be buried in sand in transparent vials or jars. Students may detect an unpleasant odor, which you identify as evidence of bacterial decay. The foul odor usually associated with the decay of organisms is evidence of bacterial action.

Yeast

Yeast cultures can be prepared using either banana, apple or molasses. Banana or apple media may be prepared by taking slices of the unbruised fruit, placing it in a jar and sprinkling dried yeast on the fruit. The molasses media is prepared by mixing one part molasses with three parts water, then sprinkling dried yeast on top of the media.

Molds

To study the growth of bread mold: Place bread in each of two wide mouth jars, and leave the jars uncovered for a day in the air of a kitchen or basement. Add a few drops of water then screw the lids on tightly. Then place both jars in a warm place for several days. (Jars can be substituted with the use of sandwich bags with twist tops.) To show the development of different molds in food material, expose a variety of foods (bread, cheese, fruit skins, banana peels or cooled cooked potatoes) to the air. Moisten and place in enclosed jars. Examine each day. Check for kind, color and size.

Sources:

Imogene Forte, Mary Ann; Robbie Tupa Pangle., Center Stuff For Nooks, Crannies and Corners (1973) Inventive Publications, Inc., Nashville, Tenn. pp. 182-189.

Lockard, J. David., "Fungi As A Teaching Tool", Science and Children, Vol. 1, No. 8, May 1964.

Karplus, Robert (director), SCIS Communities, Rand McNally and Co., Chicago, p. 74.

# DIVERSITY IN PLANTS AND ANIMALS

## CHLAMYDOMONAS, AMOEBA, PARAMECIUM, EUGLENA, SPIROGYRA VOLVOX, HYDRA, DAPHNIA AND MOSSES

### Professionally Related Activities, Demonstrations, and Discussion

#### Activities

1. Examine the single cellular, multicellular and colonial organisms with the SCIS microscope, eye glass lenses and hand lenses.

2. Play "Hydra Game" after examination of the Hydra (Fagle and Mason, 1972, p. 14).

3. Tour Science Education Culture Center.

#### Demonstrations

Terrarium preparation using mosses.

#### Discussion

1. Inform students of easy culturing procedures for micro organisms.

2. Discussion of where mosses are found.

#### Supplemental handout

1. Addresses to write to for free material related to elementary sciences.

2. Micro organisms: Hydra Game.

Discussion

1. Poor motor coordination of primary and special education student.

2. Lack of microscopes at elementary schools.

3. Collect pond or ditch water, bring back to classroom for examination (Christenson, 1971, p. 30).

4. Obtaining eye glass lenses from optometrist.

5. Organize mushroom hunt (Sand, Tillery and Trowbridge, 1970, p. 226).

Supplemental Handout

Bacteria and Fungi.

SCIENCE 1261
Supplemental Handout
Microorganisms

Microorganisms play a vital role in the world. They are at the beginning of many food chains, including most of the aquatic chains. Microorganisms are responsible for the greater part of the degradation of organic materials, restoring these to forms usable by green plants.

Microorganisms also provide material for unlimited research in life histories, structures, physiology and internal structure. Many species are easily cultured and multiply rapidly.

The Hydra Game

Four children form a Hydra by placing one arm around another's shoulders while slowly waving the free arm above their circle of bodies. A fifth child takes a large rubber ball representing a Daphnia and gently tossing it into the air approaching the Hydra. When the Daphnia comes in to the tactile zone of the Hydra, it is quickly moved into the Hydra's body.

Fagle and Mason, "The Hydra Game", Science and Children, Vol. 10, No. 3, November, 72, pp. 14-15.

# DIVERSITY IN VASCULAR PLANTS: FERNS, CONIFERS AND FLOWERING PLANTS

# CELLS AND THEIR ORGANIZATION

## Professionally Related Activities, Demonstrations and Discussion

### Activities

1. Locate and collect fern sporophyte for examination during laboratory period.

2. Collect staminate cones and seed cones of common pines for examination during laboratory period.

3. Examine electron micrographs for various cell organells.

4. Examine models of cellular organells.

### Demonstrations

None.

### Discussion

1. Discussion of a child's concept of the cell.

2. Discussion of common products of the pine tree.

3. Obtaining flowers from florist at low cost.

# PHYSICAL ASPECTS OF LIFE AND CHEMICAL ASPECTS OF LIFE

## Professionally Related Activities, Demonstrations, and Discussion

### Activities

1. Diffusion through a balloon. Put three drops of perfume in a balloon, then blow up. Push balloon into beaker. Smell beaker 15 minutes later.

2. Place prunes in beaker of water. Examine in 15 minutes for diffusion of water into prune.

3. Place cucumber slices in a bowl of water and in a bowl of water containing salt. Check for crispness in 30 minutes (Cobb, 1972, p. 91).

4. Make a poster using example from the protein group, carbohydrate group and lipid group. Turned in the next class period.

### Demonstrations

1. Cut potato in half and scoop out hole in one half of potato, place a tea spoon of salt in scooped out area. Observe in 15 minutes for evidence of diffusion (Morholt, Brandwein, and Joseph, 1966, p. 205).

2. Drop a lump of sugar (solute) into a glass of water (solvent), let stand for 10 minutes. Ask the question, "What happened to the lump of sugar?". Then taste the solution with a straw (Cobb, 1972, p. 15).

### Discussion

1. Most materials used in today's lab are commonly found in most kitchens.

2. Have students bring samples from home to be used in testing for

carbohydrates, proteins or lipids.

3. Arrange for a trip to a testing laboratory, such as in a fungi dairy plant, processing plant, or hospital. The technicians can how the class some of the routine testing procedures, similar to the ones in the laboratory activity.

4. (Intermediate class) Test different soft drinks containing sugar and sugar free for the amounts of reducing sugars present.

5. Use homemade starch for iodine test.

# MENDELIAN INHERITANCE

## Professionally Related Activities, Demonstrations, and Dicussion

### Activities

1. Human genetic traits
    A. Tongue roller
    B. Pigmented iris
    C. Widow's Peak
    D. Free earlobe
    E. Taste PTC
    F. Straight thumb
    G. Bent little finger
    H. Left thumb on top
    I. Short second finger
2. Dracula experiment (Backos, 1976, p. 41)

### Demonstrations

Instructor portrayal of Dracula, using halloween costume.

### Discussion

1. Impress upon students the effects of genetic mutation.
2. Visit a medical laboratory and observe methods of blood testing.

# PHOTOSYNTHESIS

## Professionally Related Activities, Demonstrations, and Discussion

### Activities

1. Plant pea and bean seeds for later use. Instruct students in proper soil preparation to insure seed germination.

2. Set up apparatus to demonstrate cooperation between the processes of photosynthesis and respiration. Examine during next week lab period (topic respiration).

Material: 3 jars with air tight lids
2 small aquatic snails
2 stalks of elodea
spring or pond water

Set up: One jar containing water and elodea.
One jar containing water, elodea and a snail.
One jar containing water and snail.

3. Ask students to write a hypothesis as to the outcome of the contents of the three jars.

### Demonstrations

None.

### Discussion

1. Place between light source and elodea a colored piece of cellophane and examine the differences in the rate of oxygen production.

2. Most scientists now agree that nearly all the oxygen we breathe is generated by marine plankton (diatoms).

3. Some children think plants absorb food from the soil through the roots. Plants do take in water and minerals, but these are not food for the plant. Students should be able to infer that soil does not provide food for plants.

# DIGESTION AND RESPIRATION

## Professionally Related Activities, Demonstrations, and Discussion

### Activities

1. Chew a soda cracker (no salt) well and hold it in your mouth for five minutes. Salivary amylase breaks down starch to sugars (Cobb, 1972, p. 51).

2. Examine the three jars prepared the previous week containing snails and elodea.

3. Test for amount of carbon dioxide present in exhaled air. Hold breath for 0 seconds, 10 seconds, 20 seconds and 30 seconds at a time. Then, attempt to extinguish candle flame by exhaling on the flame.

### Demonstration

Place a slice of well browned toast in dilute iodine solution. The inside white bread will turn black, indicating the presence of starch. The well browned surface will not turn black indicating that starch is not present (Cobb, 1972, p. 51).

### Discussion

1. Why does the cracker when held in the mouth for five minutes taste sweet?

2. Which jar examined in the second activities shows signs of life? What relationship exists between the process of photosynthesis and respiration.

3. Why is toast eaten in an upset stomach?

4. What does holding your breath for different lengths of time have to do with extinguishing the candle flame?

5. Respiration and breathing are not synonymous.

# BIOLOGICAL TRANSPORT AND COORDINATION AND BEHAVIOR

## Professionally Related Activities, Demonstrations, and Discussion

### Activities

Classical conditioning of students. Instruct students to raise right hand when a verbal command is given. The instructor blows a whistle each time a verbal command is given. After about ten trials, the instructor blows the whistle without giving the verbal command. Observe results.

### Demonstrations

1. The instructor places a plate of glass on dry grass in direct sunlight three hours prior to the laboratory period. Observe the under surface of the glass. Where did the water come from that appeared on the glass?

2. The response of *Paramecium caudata* to electrical stimulation (Morholt, Brandwein and Joseph, 1966, p. 299).

### Discussion

1. Discuss conditioned responses.

2. Discuss factors that could increase or decrease the rate of transpiration.

3. Observation of geotropism: trees growing on steep hillside.

# PLANT ANATOMY AND DEVELOPMENT

## Professionally Related Activities, Demonstrations and Discussion

### Activities

1. Place sweet potatoes in water held by toothpicks. Allow students to take sweet potatoes home and maintain.

2. Examine several stumps, estimate age by counting growth rings.

3. Examine Mini Unit on Plants and Science Work Book on Plants (Casey, Langley, Wetherington, Childs and Byrd; 1977).

### Demonstration

Show students various foods and pictures of foods and ask them what plant and what part of the plant is consumed.

### Discussion

1. Suggest trip to garden center or greenhouse.

2. Have students draw pictures of plant parts we eat.

3. Have students bring plants to school and discuss various types of plants found in the home.

# SCAVENGER HUNT

## Professionally Related Activities, Demonstrations and Discussion

### Activity

Provide students with list of items to be collected on scavenger hunt. The following items were included on the list:

two different-shaped tree leaves

an insect

a piece of bark

a smooth stone

a dandelion leaf

a blade of green grass

a pine cone

two seeds

a wild flower

a stem from a weed

moss gametophyte

(Adapted from Coble, 1977). Location of scavenger hunt: Green Springs Park, East Fifth Street, Greenville, North Carolina.

### Demonstration

None.

### Discussion

1. Way of teaching categorization to special education or primary students (colors, numbers, etc.)

2. Give students a chance to explore the outdoors.

3. Suggest other items to be collected.
4. Suggest other locations for scavenger hunts.
5. Means of reinforcing lessons taught in class.

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# APPENDIX C

# CORRESPONDENCE

THE PENNSYLVANIA STATE UNIVERSITY
CHAMBERS BUILDING
UNIVERSITY PARK, PENNSYLVANIA 16802

College of Education
Division of Academic
Curriculum and Instruction

July 27, 1977

Mr. Tom Koballa
Department of Science Education
East Carolina University
Greenville, NC 27834

Dear Tom:

I have pulled from my files both the Christman Science From Concepts Achievement Test and my attitude scale. I lost my key to the Christman test, but I have quickly checked what I am fairly sure are the answers. The scoring of the attitude scale is described on a copy of the most recently revised scale. The scale has had a reliability coefficient alpha of around .90.

I am also including several copies of an attitude research newsletter that I am editing and sending to those across the nation who are interested. I will be sending No. 3 out soon. Do you want included on my mailing list? Would you consider writing a 40 or 50 word review of your research that I might include in a later issue of the newsletter? I am also sending you a reference list.

Sincerely,

Robert L. Shrigley

Robert L. Shrigley
Associate Professor
of Education

RLS/cdl

cc: Dr. Gene Christman

P.S. Just an aside--I have spent pleasant vacations in Greenville (and Nags Head). Our friends, the George Hawkins, who now live in Texas, were our contacts in the area.