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ABSTRACT

This report presents data collected for the evaluation of the Comprehensive Program for Science Teacher Education at the University of South Dakota and conclusions derived from these data. The participants in the study were inservice secondary science teachers enrolled in the Comprehensive Program. The participants were pre- and post-tested in: science subject matter competency; understanding of science; attitudes toward mathematics, science, science teaching, and laboratory work; and the nature of the science classroom, and laboratory activities which the participants feel should be used for secondary school science instruction. Resulting data are reported and analyzed, along with an extensive profile of the participants' teaching experience. The primary aim of the Comprehensive Program was to develop the subject matter and mathematics competencies required to teach modern science courses. Analysis results of the data collected in this evaluation show that this objective was met. As a result of this evaluation, the program focus at the University of South Dakota has been changed to be a much more direct collaborative effort with school districts within its region. This involves creating awareness of newer curricular materials, helping districts with adoption decisions, and then assisting with implementation. (MLH)

# A TECHNICAL REPORT

EDUCATIONAL RESEARCH & SERVICE CENTER

SCHOOL OF EDUCATION
UNIVERSITY OF SOUTH DAKOTA
VERMILLION, SOUTH DAKOTA

# COMPREHENSIVE PROGRAM FOR SCIENCE TEACHER EDUCATION EVALUATION REPORT NUMBER TWO

The University of South Dakota

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## Index of the Major Areas Covered in the Report



## Index of Appendices

Introduction

This report is based on a set of evaluation guidelines and instruments which was prepared for the purpose of evaluating the Comprehensive National Science Foundation Program for Science Teacher Education at the University of South Dakota. An extensive profile of measures was developed so that a total evaluation as well as an evaluation of each phase could be obtained.

The following general procedural information is provided to help the reader understand the report which follows.

A. Basic Program Evaluation Procedures and Instrumentation

1. Participants (Descriptive information p. 4.)

Data recorded in this report were collected on participants in the following components.

- All participants in the Unitary CHEMS Component held in the summer of '72
- All participants in the Unitary General Science Component held in the summer of '72
- All participants in the 1972-1973 Academic Year Component

Pre- and posttest data were collected from the program participants in the following selected areas (instrument used is shown in parenthesis). They were given at the beginning and at the end of the program.

a. Participants' science subject matter competency (specific instruments were developed for each component). p. 13.
b. The nature of the science classroom and laboratory activities which the participants feel should be used for secondary school science instruction (Science Classroom Activities Checklist: Teacher Perceptions). p. 15.
c. Participants' understanding of science (TOUS-Test on Understanding Science). p. 17.
d. Participants' attitudes toward mathematics, science, science teaching, and laboratory work (Semantic Differential Test in Science). p. 22.

Basic descriptive information about participants and their teaching situations was collected prior to program participation (spring '72) by means of a teacher questionnaire mailed to them at their schools. Besides collecting basic descriptive information (age, sex, grades and classes taught, etc.), this questionnaire provided information on the age of curricular materials used and variables which will be evaluated assuming there is a relationship to program impact. A post-test was given to the participants of the summer of '72 institutes, in the spring of '73, after completion of a full year of teaching. The questions were designed to determine any significant changes in the attitudes toward and applications of the science principles taught in the program after an opportunity to put them into practice. The Academic Year Component participants did not receive the post-questionnaire since the component was still in session and the interpretation of the results would assume a full year of instruction by the participant after the completion of the program. p. 21.

Information on the operation of the Comprehensive Program Components was collected from participants during the last week of each component by means of questionnaires. Basic information on housing, communication, and other operations-type information was collected. Questionnaires were developed to account for specific differences in the operation of components. p.31.

2. Participants' Students (Descriptive Information p. 11.)

Pretest data was collected from participants' students through instruments mailed to the participants in the Spring of 1972, prior to the participant entering the program. A post-test was given to the participants' students in the Spring of 1973 after the participants had completed a year of teaching subsequent to their program participation. It should be noted that because the pre- and posttest data were collected in different school years, and because the students in a participant's classes vary from one academic year to the next, no assumption could be made initially with reference to the equality of the two samples drawn. However, a pre-posttest comparison of the basic descriptive information about participants' students and their school-related experiences in the field of science yielded no significant differences between the two samples. The Academic Year Component participants did not receive the post-questionnaire since the component was still in session and the interpretation of the results would assume a full year of teaching after the completion of the program. Therefore, no results will be reported with reference to the students of participants in the Biology or Chemistry sections of the Academic Year Component.

Information with specific regard to the subject matter areas which participants taught was obtained prior to the issuance of pre- and posttest materials. The participants were then asked to test a class in the subject matter area most closely associated with the institute which they planned to attend (e.g., CHEMS participants were asked to test one of their chemistry classes, etc.). After having been informed as to the subject matter area of the class in which testing was to be performed, the participants were instructed to utilize the following sampling procedure:

a. List all of the classes which you teach in this subject matter area according to the order in which you meet them in a typical day (or week if you do not meet daily).

b. If you have one class of the specified type, test that one.
   If you have two classes, test the first.
   If you have three classes, test the second.
   If you have four classes, test the second.
   If you have five classes, test the third.
   If you have six classes, test the fifth.

c. Please use the class selected by this procedure regardless of whether you feel this is a typical class or not.

Data were collected in the following areas (instruments used are shown in parenthesis).

a. The nature of the science activities which the participants do use for their science instruction as viewed through the eyes of their students. (<u>Science Classroom Activities Checklist</u>: <u>Student Perceptions</u>). p. 16.

b. Students' attitudes toward science and other science related areas. (<u>Semantic Differential Test in Science</u>). p. 26.

c. Basic descriptive information about participants' students and their school-related experiences in the field of science. (<u>Student Questionnaire</u>) p. 11.

d. Students' understanding of science. (<u>Test on Understanding Science</u>). p. 20.

Each participant received a packet which contained sufficient material for 27 students and distribution proceeded as follows:

Student #1 - Student Questionnaire
Science Classroom Activities Checklist
Machine Scorable Answer Sheet
Semantic Differential Questionnaire

Student #2 - Student Questionnaire
Science Classroom Activities Checklist
Machine Scorable Answer Sheet
Semantic Differential Questionnaire

Student #3 - TOUS (Test on Understanding Science) with Machine Scorable Answer Sheet

Thus, in a class of 27 students, the distribution would be as follows:

| | |
|---|---|
| 18 students | Student Questionnaire<br>Science Classroom Activities Checklist<br>Semantic Differential Questionnaire |

9 students -- TOUS (Test on Understanding Science)

In classes which contained less than 27 students the distribution remained in approximately the same proportion -- 2:1. Directions for the administration of these instruments were included in each packet.

The data from all the students of a particular participant were combined resulting in a mean student score for each participant on each of the items tapped by the instruments administered to the participants' students.

3. Data Analysis

All data were coded, condensed into means where necessary, and put on cards for analysis by computer. Descriptive information was generated using the Princeton Statistical Package (P-STAT) Versions 3.04 and 3.05 developed by Roald Buhler at the Princeton University Computer Center in 1971. Significant differences between participants' pre- and posttest scores were determined using a t-Test for Matched Samples program within the package.

B. Organization of the Report

The analysis and discussion of the data which follows will be presented in four sections. These are, in their order of presentation: (I) Descriptive Information on Participants and their Students, p. 4 ., (II) Evaluation of Program Objectives, p. 13 ., (III) Program Processes Evaluation, p. 31 ., and (IV) Two Brief Summaries, p. 39.

## I. DESCRIPTIVE INFORMATION ON PARTICIPANTS AND THEIR STUDENTS

### A. Participants

This information is based on a questionnaire that was sent to each teacher prior to participation in the Comprehensive Program. The program components represented by the data are: (1) Unitary CHEMS Component (n=18), (2) Earth Science Section of the General Science Component (n=17), (3) Physical Science Section of the General Science Component (n=18), (4) Biology Section of the Academic Year Component (n=12), and (5) Chemistry Section of the Academic Year Component (n=4).

#### 1. States Represented and Number of Participants Per State

Table I-1 provides information on the areal distribution of participants by state. The data demonstrate that the Comprehensive Program at the University of South Dakota has taken a regional focus.

#### 2. Age of Participants

The mean age of the participants in the total program was 31.57 years (S.D.=7.84). The range in age was from 23 to 62 years. The Academic Year Component had, on the average, younger participants ($\bar{x}$ = 30); Unitary Component participants were generally somewhat older ($\bar{x}$ = 32).

#### 3. Sex of Participants

About 91% of the participants were males. Approximately 80% of the participants in the Unitary General Science Component were males while all participants in the remaining components were males.

#### 4. Grade Levels at Which Participants Teach

Table I-2 provides information on the grade levels at which the participants in the various program components taught. One of the most striking characteristics is the number of participants who taught at both the "junior high" and "high school" levels. Over 75% of the participants either taught full-time, or have some teaching responsibilities, below grade ten.

#### 5. Subject Taught

Table I-3 provides information on the subject area or combination of areas which participants taught. Seventy-two percent of the participants teach more than one subject and approximately 38% teach in more than two areas. NOTE: 15 participants could not fill out the Teacher Questionnaire mailed to them at their school because their individual system could not be measured or the lack of time made it impossible. The participants' non-response was appreciated since it lead to accurate and complete data by those who did complete it.

#### 6. Organizational Structure of the Participants' School System

The major organizational structures of 54 home school systems were: (1) K-6, 7-8, 9-12 (37%); (2) K-6, 7-9, 10-12 (33%); and (3) K-8, 9-12 (9%).

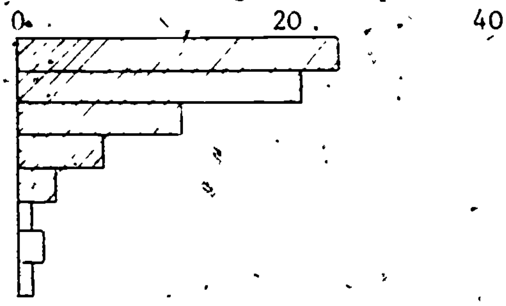
TABLE I-1

AREAL DISTRIBUTION OF PARTICIPANTS

COMPREHENSIVE SCIENCE EDUCATION PROGRAM

UNIVERSITY OF SOUTH DAKOTA

Number of Participants




| | Breakdown* | | |
|---|---|---|---|
| | UC | UGS | AY |
| Iowa | 6 | 14 | 3 |
| South Dakota | 4 | 12 | 5 |
| Nebraska | 6 | 2 | 3 |
| Minnesota | 1 | 3 | 3 |
| North Dakota | | 2 | 1 |
| New York | | | 1 |
| Illinois | 1 | 1 | |
| Kansas | | 1 | |

Regional Participation = 94%

*UC = Unitary Chemistry Component (summer '72)

UGS = Unitary General Science Component (summer '72)

AY = Academic Year Component (1972 - 73)

TABLE I-2

Grade Levels at Which Participants Taught Recorded by Program Component/Sections

| Grade Level | Component/Section UC* | UGS/ES* | UGS/PS* | AY/B* | AY/C* | Total |
|---|---|---|---|---|---|---|
| Elementary | | 1 | | | | 1 |
| 7 | 3 | 2 | 2 | 1 | | 8 |
| 8 | 1 | 1 | | | | 2 |
| 9 | 4 | 2 | 2 | | | 8 |
| 10 | 1 | 2 | 1 | 1 | | 5 |
| 11 | | | | | | 0 |
| 12 | | | | | | 0 |
| 5-9 | | 1 | 5 | | | 6 |
| 7-9 | | 5 | 3 | | | 8 |
| 7-12 | 5 | 2 | 4 | 4 | 4 | 19 |
| 10-12 | 4 | 1 | 1 | 6 | | 12 |
| TOTAL | 18 | 17 | 18 | 12 | 4 | 69 |

*UC = Unitary CHEMS Component

UGS/ES = Unitary General Science Component - Earth Science Section

UGS/PS = Unitary General Science Component - Physical Science Section

AY/B = Academic Year Component - Biology Section

AY/C = Academic Year Component - Chemistry Section

TABLE I-3

Subject Areas the Participants Taught

Broken Down by Component/Sections*

| | UC | UGS/ES | UGS/PS | AY/B | AY/C | Total |
|---|---|---|---|---|---|---|
| Chemistry | | | | 1 | | 1 |
| Earth Science | | 2 | | | | 2 |
| General Science | 4 | | | | | 4 |
| Life Science | 2 | 1 | | 1 | | 4 |
| Physical Science | 1 | | | | | 1 |
| Mathematics | | | 1 | | | 1 |
| Biology | | | | 2 | | 2 |
| Chemistry & Biology | | | | 1 | | 1 |
| Chemistry & Physics | 2 | | | | | 2 |
| Chemistry & Physics & Phys. Science | 1 | 1 | 1 | | | 3 |
| Chemistry & Biology & Physics | | 1 | | | 1 | 1 |
| Chemistry & Physics & Electricity | 1 | | | | | 1 |
| Chemistry & General Science & Other | | | 1 | | | 1 |
| Chemistry & Earth Science & Math & Physics | | | | | 1 | 1 |
| Chemistry & Biology & General Science & Other | | | | 1 | | 1 |
| Chemistry & Physics & General Science & Other | 2 | | | | 1 | 3 |
| Earth Science & Life Science | | 2 | 1 | | | 3 |
| Earth Science & Physical Science | | 1 | | | | 1 |
| Earth Science & Biology | | | 1 | | | 1 |
| Earth Science & Physical Science & Mathematics | | 1 | | | | 1 |
| Earth Science & Biology & Life Science & Other | | | | 2 | | 2 |
| General Science & Biology | | | 1 | | | 1 |
| General Science & Mathematics | | 1 | 1 | | | 2 |
| General Science & Mathematics & Other | | 2 | 1 | | | 3 |
| Life Science & Mathematics | | | 1 | | | 1 |
| Life Science & Biology | 2 | | | | | 2 |
| Physical Science & Biology & Physiology & Drug Education | | 1 | | | | 1 |
| Mathematics & Physics | | | 1 | | | 1 |
| Biology & Other | | | | 3 | | 3 |
| Total | 16 | 13 | 10 | 12 | 3 | 54 |

*See p. 6 for the abbreviations

7. Years of Teaching Experience K-College

Approximately nine percent of the participants had teaching experience at the elementary school level (grades K-6). The mean number of years that these people had taught at the elementary school level was 5.2 years (S.D.=2.71).

Ninety-eight period of the participants had experience at the secondary school level (grades 7-12). The mean number of years of experience at the secondary school level recorded by program component is provided in Table I-4.

TABLE I-4

Participants' Mean Years of Secondary School Teaching Experience Recorded by Program Component/Sections

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=16) | | UGS/ES (n=13) | | UGS/PS (n=10) | | AY/B (n=12) | | AY/C (n=3) | | Total (n=54) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Years | 6.75 | 3.83 | 7.61 | 6.27 | 7.11 | 5.34 | 6.08 | 2.89 | 7.66 | 1.69 | 6.92 | 4.61 |

None of the participants had experience teaching at the college level.

8. Participants' Attitudes Toward the Textbook Materials They Were Using (like 5 to 1 dislike).

TABLE I-5

Participants' Attitudes Toward the Textbook Materials They Used In Their Teaching Recorded by Textbook Subject Area

| | Content Area | | | | | | |
|---|---|---|---|---|---|---|---|
| | Chemistry (n=18) | Earth Science (n=17) | General Science (n=17) | Physical Science (n=10) | Physics (n=13) | Math (n=19) | Biology (n=22) |
| | $\bar{x}$ | $\bar{x}$ | $\bar{x}$ | $\bar{x}$ | $\bar{x}$ | $\bar{x}$ | $\bar{x}$ |
| Attitudes Toward Textbook Materials (like 5 to 1 dislike) | 4.28 | 3.53 | 3.29 | 4.00 | 4.23 | 3.95 | 3.41 |

As indicated in Table I-5, the participants held a moderately positive view of the materials they used for their teaching. Earth Science, General Science, and Biology materials hold the lowest ratings. In the areas of Earth Science and General Science this may be due to the lower implementation rate of newer curriculum project materials as compared to chemistry and physics.

9. Textbook Materials Used by Participants

Participants were asked to record the textbook materials they were using. These textbook materials were tabulated. Only the most frequent textbooks reported will be attached to this report. A tabulation of all books being used has been compiled.

The most frequent textbooks used by participants are tabulated by subject area in Table I-6.

TABLE I-6

Tabulation of Textbook Title Frequency by Subject

| Subject | Title | Frequency | |
|---|---|---|---|
| Biology | Otto, Towle - Modern Biology. | 11 | |
| | Morrison, Cornett, Tether - Human Physiology, 1963 & 1967 | 5 | |
| | Total Teachers Reporting | | 28 |
| Earth Science | Ramsey, Burkley et.al. - Modern Earth Science, 1965 | 6 | |
| | Navarra, Strahler - Our Planet In Space, 1967 | 2 | |
| | Total Teachers Reporting | | 12 |
| Chemistry | Metcalfe, Williams, Castke - Modern Chemistry, 1966 | 5 | |
| | Smoot, Price, Barret - Chemistry—A Modern Approach, 1968 | 3 | |
| | Dull, Metcalfe, Williams - Modern Chemistry, 1962 & 1965 | 3 | |
| | Total Teachers Reporting | | 19 |
| General Science | Brandwein, Stallberg, Burnett - Life-Its Forms & Changes, 1968 | 4 | |
| | Brandwein, Stallberg, Burnett - Energy-Its Forms & Changes, 1968 | 3 | |
| | Davis, Burnett, Gross, Johnson - Science: Discovery & Progress, 1965 | 2 | |
| | Navarra, Zafforoni - Today's Basic Science, 1965 & 1967 | 2 | |
| | Total Teachers Reporting | | 19 |
| Physical Science | Introductory Physical Science Group, 1967 | 3 | |
| | Brooks, Tracy, et.al. - Modern Physical Science, 1966 | 3 | |
| | Tracy, Tropp, Friedl - Modern Physical Science, 1970 | 3 | |
| | Total Teachers Reporting | | 11 |
| Physics | Harvard Project Physics | 5 | |
| | Dull, Metcalfe, Williams, Modern Physics, 1968 | 3 | |
| | Taffel - Physics-Its Methods & Meanings, 1969 | 2 | |
| | Total Teachers Reporting | | 14 |

10. Publication Date of the Textbook Used By Participants

The approximate mean publication date of the textbook materials being used by participants for their teaching was 1967. The mode was at 1968. There were materials being used, however, that were published in the early 1960's and one participant was using materials published in 1960. A complete breakdown may be found in Appendix 6, p. 61.

11. Do Participants' Classroom Activities Include Laboratory Work?

Ninety percent of the participants indicated that their students were provided with the opportunity to be involved in laboratory activities.

12. Amount of Time Provided For Laboratory Activities

The mean time that participants spent in the science laboratory per class per week was approximately 71 minutes. This would be equivalent to about 1¼ class periods per week. Further analysis of the data shows that the time allocated to work in the laboratory is not consistent across all subject matter areas.

Participants spent approximately 54 minutes per class per week in doing laboratory work with their general science students. Physical science classes were noted as spending approximately 84 minutes per class per week (participants using IPS were found to spend approximately 170 minutes per class per week). Life science and earth science courses were found to involve laboratory work about 63 and 73 minutes per class per week respectively.

Institute participants teaching chemistry indicated they spent about 86 minutes per class per week in the laboratory. Biology and physics courses were found to involve laboratory work about 72 and 73 minutes per class per week respectively.

13. Participants' Rating of Their Laboratory Facilities (5 Excellent to 1 Non-existent)

The mean participant rating for their school's laboratory facilities was 3.11 (S.D. 1.28). Unitary Physical Science and AY chemistry participants rated their schools' science facilities somewhat lower than participants from other components. It may be true that if participants begin to use the laboratory more, their feelings toward the adequacy of their present facilities will be less positive.

14. Participants' Rating of Their Laboratory Equipment and Materials (5 Excellent to 1 Non-existent)

The mean participant rating of their schools' laboratory equipment and materials was 3.38 (S.D. 1.10). Unitary Physical Science and AY Chemistry participants rated their schools' science equipment and materials somewhat lower than did participants in other components. Again, if participants begin to use the laboratory more, their feelings toward the adequacy of their equipment and materials may change.

15. Do Participants' Students Use A Laboratory Guide?

Approximately 70% of the participants responded that their students do use a laboratory guide. The average publication date for laboratory guides used by participants' students was 1966. Of the participants who indicated that their students do use a laboratory guide, 63% use laboratory guides which accompany their textbooks, 22% write their own laboratory guides, and 15% use laboratory guides which originate from miscellaneous sources.

B. Participants' Students

This descriptive information on Unitary participants' students was obtained via student questionnaires that were sent to participants for distribution to a select sample of the students whom they taught. These questionnaires were mailed in the Spring of 1972 to each teacher prior to participation in the Comprehensive Program and again in the Spring of 1973 after the participants had completed a year of teaching subsequent to their program participation. The sampling procedures utilized in the collection of this student data are delineated on page 2 . A pre-posttest comparison of this basic descriptive information about participants' students and their school-related experiences in the field of science yielded no significant differences between the two samples drawn. The following items make up the sample description information.

1. Sex of Participants' Students

Approximately 54% of the participants' students in the pretest were males. The post-questionnaire was split exactly half and half; 50% males.

2. Age of Participants' Students

The mean age of the Unitary participants' students in the pretest was 14.59. The range in age was from 12 to 17 years. The General Science Component had, on the average, younger participants' students ($\bar{x}$ = 14.08); CHEMS participants' students were generally somewhat older ($\bar{x}$ = 15.44). There was no significant difference in the post-questionnaire.

3. Grade Level of Particpants' Students

The mean grade level of the participants' students was 8.81 in the pretest. The range in grade level was from 5th grade to 12th grade. Participants in the General Science Component had, on the average, students at a lower grade level ($\bar{x}$ = 8.18) than participants in the CHEMS component ($\bar{x}$ = 9.86) as is to be expected. There was no significant difference in the posttest.

4. How Many Full Years of Science Have Participants' Students Had Since They Entered the 5th Grade (Including the Year in Which the Questionnaire Was Filled Out)?

The students of participants in the General Science Component reported less years of science instruction since the 5th grade ($\bar{x}$ = 4.03) than the students of participants in the CHEMS Component ($\bar{x}$ = 5.40) in the pretest. This discrepancy may be accounted for in terms of the differences in age and grade level between the students of participants in the two components. There was no significant difference in the post-questionnaire.

5. Do Participants' Students Like Science? (Like 5 to 1 Dislike)

The students of participants in the Unitary Components indicated a moderately positive attitude toward science ($\bar{x}$ = 3.62) in the pretest. Again, no significant difference ($\bar{x}$ = 3.53) on the pre-post comparison.

6. Do Participants' Students Like the Science Course Which They Are Currently Taking? (Like 5 to 1 Dislike)

In general, the Unitary participants' students had a fairly positive attitude toward the science course which they were taking at the time of the pretest ($\bar{x}$ = 3.43). There was no significant change in the post-questionnaire ($\bar{x}$ = 3.43).

7. Do They Plan to Take Any More Science Courses? (Yes 5 to 1 No)

The mean of the responses indicated a 'possibly' response (3) throughout all components. The scale was 5-Definitely Yes, 4-Probably, 3-Possibly, 2-Doubtful, 1-Definitely No. There was no significant difference in the pre-post comparison.

8. Do They Plan to Go Into a Science Or Science Related Career? (Yes 5 to 1 No)

The mean response was edging on "possibly" ($\bar{x}$ = 2.56). The standard deviation was small (.2) indicating a strong "I don't know" trend on both pre and post instruments.

9. The Student's Last Report Card Grade (A 4 to 0 F)

This indicated a lower grade for the general science courses. The mean grade there was "C". The mean grade in the chemistry and biology courses was "B". Again, there was no significant difference between pre and post.

II. EVALUATION OF PROGRAM OBJECTIVES

Analysis and Discussion of the Data

The analysis and discussion will be carried on with reference to the particular area which was being evaluated.

A. Subject Matter Competency

The assessment of participants' development in subject matter competency will be presented under the heading of each program component. This is done because specific instruments were generally used for each individual component due to the needs of the participants and the nature of the subject matter being studied. The instruments are directed toward assessing the major subject matter competencies which teachers should have in order to teach the subject or subjects being emphasized in the program component. The instruments were administered on a pre- and post-participation basis. Means and standard deviations for this area may be found in Appendix 1, Tables 3-6, p. 45.

1. Unitary CHEMS Component

The CHEMS Component was directed at developing the chemistry subject matter competencies necessary for participants to teach CHEMS chemistry. Emphasis was also placed on familiarity with CHEMS curricular materials, particularly with reference to laboratory activities.

The subject matter competency of the CHEMS participants was assessed on a pre- and post-participation basis using the 1968 version of The American Chemical Society Advanced High School Chemistry Test. However, an error resulted in the data in this section being not suitable for statistical analysis. A general conclusion from the data which is available would appear to be that the participants did achieve increased competency in subject matter by the completion of the CHEMS component.

2. Unitary General Science Component

The Unitary General Science Component was composed of 34 participants of which 16 worked with the Earth Science Curriculum Project (ESCP) materials and 18 worked with Introductory Physical Science (IPS) curricular materials. There was a common mathematics program directed at providing the mathematics proficiency needed for working with either set of curricular materials.

a) Earth Science and Physical Science Mathematics Compentency

A general mathematics test was developed which assessed the desired mathematics competencies necessary for teachers who would teach the curricular materials emphasized in the General Science Component. The Earth and Physical Science participants had a significantly greater ($p < .01$) general mathematics competency at the completion of the General Science Component than they had when they began (shown in Appendix 1, Tables 1 and 2, p. 45.).

b) Earth Science and Physical Science Subject Matter Competency

Earth Science participants had significantly greater ($p < .01$) subject matter competency in earth science at the end of the summer program than they did at the beginning. This is shown in Appendix 1, Table 3, p. 45 .

The Physical Science participants also had significantly greater ($p < .01$) subject matter competency at the end of program participation than they did at the beginning. This is shown in Appendix 1, Table 4, p. 46.

Based on the information available, it is reasonable to infer that the General Science component resulted in participants gaining significantly greater subject matter competencies in general mathematics and the science areas studied.

3. Academic Year Component / Biology Section

The subject matter competency of the participants entering the Biology Section of the AY Component was assessed on a pre-post participation basis using a graduate exam developed by the University of South Dakota Biology Department. The exam consists of 125 items divided into the following subscales, (A) Animal Anatomy and Development, (B) Plant Morphology and Anatomy, (C) Genetics, (D) Cell Physiology, (E) Ecology, and (F) General Biology.

Although participants in the Biology Section of the AY Component did show gains on all subscales and the composite when pre- and posttest scores were compared, Table II-1 indicates that none of these gains were significant at the $p < .01$ level. The means are shown in Appendix 1, Table 5, p. 47.

TABLE II-1

t-Test for Matched Samples Comparing USD Graduate Biology Examination Pre- and Posttest Scores

| | AY/B Component |
|---|---|
| t Subscale A | .11 |
| t Subscale B | 2.47 |
| t Subscale C | .23 |
| t Subscale D | .41 |
| t Subscale E | 1.65 |
| t Subscale F | .75 |
| t Composite | 1.56 |
| Degress of Freedom | 10* |

*$t \geq 3.17$ to be significant at the .01 level

4. Academic Year Component / Chemistry Section

The subject matter competency of the participants entering the Chemistry Section of the AY Component was assessed on a pre-post participation basis using a broad chemistry subject matter exam developed at the University of South Dakota. A comparison of the pre- and posttest scores yielded a $t$ value of 2.00 which indicates a gain by these participants. However, because of the small number of participants in this institute, (N=3), a $t$ value of 9.93 would have been needed in order for this gain to have reached statistical significance at the .01 level. The means may be found in Appendix 1, Table 6, p. 47.

B. Instructional Activities Which Participants Feel Should Be Used and Those They Do Use For Their Instruction

1. Classroom and laboratory activities which participants feel should be used for science instruction.

Each participant responded to the Science Classroom Activities Checklist: Teacher Perceptions (SCACL:TP) immediately before and after program participation. This instrument is directed at determining the nature of the science classroom and laboratory activities which the teacher feels "should" be used for secondary school science instruction. The checklist is scored according to whether the teachers' responses are correct in terms of the activities which are thought to best implement the overall objectives of science education. The SCACL:TP is divided into seven subscales which are: (A) Student Classroom Participation, (B) Role of the Teacher in the Classroom, (C) Use of Textbook and Reference Materials, (D) Design and Use of Tests, (E) Laboratory Preparation, (F) Types of Laboratory Activities, and (G) Laboratory Follow-Up Activities. The individual questions composing the subscales are in Appendix 7, Table 1, p. 62.

The CHEMS participants entered the program in relatively good agreement with educators as to the types of activities which should be used for implementing science education programs, and, in general, they maintained this agreement. This is shown by the means and standard deviations for the SCACL which may be found in Appendix 2, Table 1, p. 48.

Table II-2 provides information which shows that the CHEMS participants' SCACL:TP posttest mean composite score was not significantly different from their mean pretest score.

TABLE II-2

t-Test for Matched Samples Comparing Science Classroom Activities Checklist: Teacher Perceptions Pre- and Posttest Scores

| | Component/Section | | | | |
|---|---|---|---|---|---|
| | UC | UGS/ES | UGS/PS | AY/B | AY/C |
| t Subscale A | 1.60 | .81 | - .27 | .00 | 1.00 |
| t Subscale B | 1.41 | - .90 | .94 | .00 | 1.73 |
| t Subscale C | .32 | - .52 | 1.05 | - 1.85 | - 1.00 |
| t Subscale D | - 1.16 | - .29 | 1.45 | .00 | 2.00 |
| t Subscale E | - .52 | 2.74 | .00 | - 1.85 | - 1.00 |
| t Subscale F | .29 | .72 | - .44 | - .77 | .00 |
| t Subscale G | .91 | .32 | 4.24 ! | - 1.14 | .00 |
| t Composite | .62 | .66 | 1.94 | - 1.05 | - 1.11 |
| Degrees of Freedom | 16 | 15 | 16 | 10 | 2 |
| Minimum t-value to be significant at p ≤ .01 | 2.92 | 2.95 | 2.92 | 3.17 | 9.93 |

The SCACL:TP posttest mean composite scores of participants in the Earth Science Section of the General Science Component were not significantly different from their mean pretest composite scores. An analysis of the subscale t-test value in Table II-2 also indicates no significant pre-posttest changes on any of the subscales.

Table II-2 provides information which shows that the Physical Science participants' (General Science Component) SCACL:TP posttest mean composite scores were not significantly different from their mean pretest composite scores. Subscale analysis reveals, however, that they did demonstrate significant pre- posttest changes on Subscale G (Laboratory Follow-Up Activities). This reflects a change on the part of the participants toward an increased utilization of follow-up activities in conjunction with student laboratories.

Information is provided on Table II-2 which shows that the Biology participants' (Academic Year Component) SCACL:TP posttest mean composite scores were not significantly different from their mean pretest composite scores. An analysis of the subscale scores also indicates no significant pre-posttest changes on any of the subscales.

The SCACL:TP posttest mean composite scores of participants in the Chemistry Section of the Academic Year Component were not significantly different from their mean pretest composite scores. An analysis of the subscale scores also indicates no significant pre-posttest changes on any of the subscales. The extremely small number of participants in this component, (three), should be kept in mind, however, because of its effect upon the degrees of freedom when calculating the t-tests.

In general, the participants entered the program in relatively good agreement with science educators as to the type of classroom and laboratory activities which should be used for science instruction as shown in the means found in Appendix 2, Table 1, p. 48. The program components contributed positively in several areas toward strengthening this agreement.

2. Classroom and Laboratory Activities Which Participants Do Use For Their Science Instruction

The types of classroom and laboratory activities which the Comprehensive Program participants do use for science instructionwere assessed using the Science Classroom Activities Checklist: Student Perceptions (SCACL:SP). The nature of the activities the students perceived their teachers to use was assessed in the spring of the year previous to their teachers' participation in the Comprehensive Program and again in the spring of the year following program participation. The SCACL:SP is a parallel instrument to the SCACL;TP discussed previously. For the sake of convenience, the seven subscales into which the SCACL is divided will be enumerated again: (A) Student Classroom Participation, (B) Role of the Teacher in the Classroom, (C) Use of Textbook and Reference Materials, (D) Design and Use of Tests, (E) Laboratory Preparation, (F) Types of Laboratory Activities, and (G) Laboratory Follow-Up Activities. The individual questions composing the subscales are in Appendix 7, Table 2, p. 65. Means and standard deviations for the SCACL may be found in Appendix 2, Table 2, p. 49.

Table II-3 provides information which shows that the CHEMS participants' students' SCACL:SP posttest mean composite score was not significantly different from their mean pretest score. An analysis of the subscales reveals no significant changes in the specific areas measured by the SCACL:SP.

TABLE II-3

t-Test for Matched Samples Comparing Science Classroom Activities Checklist: Student Perceptions Pre- and Posttest Scores

| | Component/Section | | |
|---|---|---|---|
| | UC | UGS/ES | UGS/PS |
| t Subscale A | 1.45 | .14 | .29 |
| t Subscale B | - 1.88 | - .73 | - .02 |
| t Subscale C | 1.83 | .00 | 1.37 |
| t Subscale D | .66 | .48 | 3.53 ! |
| t Subscale E | .35 | - .74 | - .05 |
| t Subscale F | 2.07 | 1.75 | 1.76 |
| t Subscale G | 1.95 | .17 | 1.74 |
| t Composite | 1.29 | - .16 | 1.88 |
| Degrees of Freedom | 11 | 8 | 10 |
| Minimum t-value to be significant at the $p \leq .01$ | 3.11 | 3.36 | 3.17 |

The students of participants in the Earth Science Section of the General Science Component did not demonstrate a significant change in their overall perceptions of the activities which were being utilized in their science classes. An analysis of the subscales reveals no significant changes in the specific areas measured by the SCACL:SP in Table II-3.

Table II-3 provides information which shows that the Physical Science participants' students' (General Science Component) SCACL:SP posttest mean composite scores were not significantly different from their mean pretest composite scores. Subscale analysis reveal, however, that they did demonstrate significant pre-posttest changes on Subscale D (Design and Use of Tests).

C. Understanding of Science

1. Participants' Understanding of Science

Each participant responded to the Test on Understanding Science (TOUS), both previous to program participation and at the completion of the program. The TOUS test is divided into three subscales which are (1) The Scientific Enterprise, (2) The Scientist, and (3) Methods and Aims of Science. Means and standard deviations for the TOUS may be found in Appendix 3, Table 1, p. 50.

The composite mean of the pretest scores for all participants is 40.74. A comparison of this TOUS mean pretest score to Table II-5 indicates that the participants, on the average, ranked at about the 87th percentile when compared to the 1960 national sample of twelfth grade students. The post-component composite scores have a mean of 41.68. This indicates that after having completed the program, the participants, on the average, ranked at the 89th percentile when compared to the 1960 national sample of twelfth grade students. Probably the most meaningful aspect of this comparison is that the participants ranked near the 90th percentile when compared to a national sample of twelfth grade students following their program participation.

Further study of the means on p. 50 shows that all components with the exception of CHEMS and the Biology Section of the Academic Year Component demonstrated gains on the TOUS when pre-component and post-component composite scores are compared. Table II-4 provides information which shows, however, that none of the components demonstrated a significant change in their performance on the TOUS.

TABLE II-4
t-Test For Matched Samples Comparing
TOUS Pre- and Posttest Scores.

| Component/ Section | t for Subscale 1 | t for Subscale 2 | t for Subscale 3 | t for Composite | Degrees of Freedom | Minimum t-value to be significant at $p \leq .01$ |
|---|---|---|---|---|---|---|
| UC | - .37 | .33 | - .59 | - .23 | 16 | 2.92 |
| UGS/ES | 1.34 | 1.98 | .88 | 1.41 | 15 | 2.95 |
| UGS/PS | 1.94 | .60 | 1.12 | 1.60 | 16 | 2.92 |
| AY/B | - .64 | - .91 | .15 | - .45 | 10 | 3.17 |
| AY/C | -1.00 | - .38 | - .76 | -4.00 | 2 | 9.93 |

TABLE II-5 provides percentile ranks based on a nationwide sample of 3,009 public and private school students tested in October, 1960 (This is the only normative data of which the author is aware).

TABLE II-5**

TENTATIVE NORMS -- Test on Understanding Science (TOUS)

Percentile Ranks for High School Students*

| TOUS Total Score | Grade 9# | Grade 10 | Grade 11 | Grade 12 |
|---|---|---|---|---|
| 48 | | | | 99 |
| 47 | | | 99 | |
| 46 | | 99 | 98 | 98 |
| 45 | | | 97 | 96 |
| 44 | | 98 | 96 | 95 |
| 43 | | 97 | 94 | 93 |
| 42 | | 96 | 92 | 90 |
| 41 | 99 | 94 | 90 | 88 |
| 40 | 98 | 92 | 87 | 85 |
| 39 | 97 | 91 | 84 | 82 |
| 38 | 94 | 89 | 81 | 78 |
| 37 | 90 | 86 | 78 | 74 |
| 36 | 85 | 84 | 74 | 69 |
| 35 | 81 | 81 | 69 | 63 |
| 34 | 75 | 77 | 64 | 59 |
| 33 | 69 | 72 | 58 | 54 |
| 32 | 64 | 67 | 52 | 47 |
| 31 | 58 | 63 | 46 | 41 |
| 30 | 52 | 58 | 41 | 36 |
| 29 | 45 | 52 | 36 | 32 |
| 28 | 38 | 46 | 31 | 28 |
| 27 | 32 | 40 | 28 | 24 |
| 26 | 27 | 36 | 22 | 20 |
| 25 | 22 | 32 | 18 | 16 |
| 24 | 17 | 28 | 15 | 14 |
| 23 | 12 | 23 | 12 | 12 |
| 22 | 10 | 19 | 9 | 9 |
| 21 | 9 | 16 | 7 | 7 |
| 20 | 7 | 14 | 5 | 5 |
| 19 | 6 | 11 | 4 | 4 |
| 18 | 4 | 8 | 2 | 3 |
| 17 | | 7 | | 2 |
| 16 | 2 | 5 | 1 | |
| 15 | | 4 | | 1 |
| 14 | | 3 | | |
| 13 | | 2 | | |
| Mean Score | 29.47 | 28.58 | 31.57 | 32.25 |
| Standard Deviation | 6.03 | 7.66 | 7.02 | 7.38 |
| Number of Students | 198 | 1064 | 994 | 753 |

*Based on a nationwide sample of 3009 public and private school students tested in October 1960. (The means and standard deviations are based on 2980 of the 3009 students: 9th Grade, 198 students; 10th Grade, 1055; 11th Grade, 985; 12th Grade, 742.

#Figures for Grade 9 should be used with caution, since they are based on a relatively small sample group.

**Taken from TEST ON UNDERSTANDING SCIENCE, Manual for Administering, Scoring, and Interpreting Scores, Educational Testing Service, 1961.

2. Participants' Students Understanding of Science

Participants' students responded to the Test on Understanding Science (TOUS) both previous to their teachers' program participation and a year after completion of the program. The student TOUS is a parallel instrument to the teacher TOUS discussed previously. Means and standard deviations for the TOUS may be found in Appendix 3, Table 2, p. 51.

All components for which we have complete data, with the exception of CHEMS, demonstrated gains on the student TOUS when overall pre-component and post-component scores are compared. Table II-6 provides information which shows, however, that none of the components showed significant changes.

It is interesting to note that a comparison with the 1960 national norms shows that CHEMS participants' students (grade 11) score, on the average, between one and one and one-half points lower than the eleventh grade national sample. The earth and physical science participants' students (grades 8 and 9) score, on the average, approximately four points lower than the ninth grade national sample.

TABLE II-6

t-Test for Matched Samples Comparing Student TOUS Pre- and Posttest Scores

| Component/ Section | t for Subscale 1 | t for Subscale 2 | t for Subscale 3 | t for Composite | Degrees of Freedom | Minimum t-value to be significant at p < .01 |
|---|---|---|---|---|---|---|
| UC | -.52 | -.52 | -1.14 | -.93 | 7 | 3.50 |
| UGS/ES | 1.16 | .06 | 2.06 | 1.38 | 5 | 4.03 |
| UGS/PS | -.67 | .15 | .28 | .07 | 7 | 3.50 |

D. Attitudes of Participants and Their Students

1. Participants

Three important pre-posttest variables on the Teacher Questionnaire measure program impact. The measures consist of the mean time the participants' class spends in the laboratory, the participants' attitudes toward teaching (Like 5 to 1 Dislike), and the participants' attitudes toward their students. The Teacher Questionnaires were very well received by the participants. They appreciated the questions and responded well, resulting in very complete and concise data. The individualized programs had trouble and some found it and the student questionnaires impossible to complete.

Table II-7 shows the matched t-test value for the comparison of lab time. The Unitary CHEMS Component did increase significantly in the amount of time spent in the laboratory. The other component/sections did not change significantly in this variable. The means are in Appendix 5, Table 1, p. 60.

TABLE II-7

t-Test for Matched Samples Comparing Participants' Pre and Post Actual Laboratory Time (Minutes)

| | Component/Section | | | |
|---|---|---|---|---|
| | UC | UGS/ES | UGS/PS | Total |
| t-Value | 3.32! | -.01 | -.64 | 1.36 |
| Degrees of Freedom | 10 | 5 | 5 | 22 |
| Minimum t-Value to be significant at $p < .01$ | 3.17 | 4.03 | 4.03 | 2.82 |

Table II-8 is the t-Test of pre- and posttest attitude toward teaching. Although the trend is toward a more unfavorable attitude the means (Appendix 5, Table 2, p.60 .) show a very high attitude toward teaching.

TABLE II-8

t-Test for Matched Samples Comparing Participants' Pre and Post Attitude Toward Teaching

| | Component/Section | | | |
|---|---|---|---|---|
| | UC | UGS/ES | UGS/PS | Total |
| t-Value | -1.64 | .05 | -1.98 | -1.82 |
| Degrees of Freedom | 11 | 6 | 7 | 25 |
| Minimum t-Value to be significant at $p < .01$ | 3.11 | 3.71 | 3.50 | 2.79 |

Table II-9 holds the t-test values for the comparison of the participants' pre- and posttest attitude toward their students. There is no apparent overall trend. The Unitary CHEMS Component has a rising attitude while the Unitary General Science Component indicates a trend toward declining attitude. The means are in Appendix 5, Table 3, p. 60.

TABLE II-9

t-Test for Matched Samples Comparing
Participants' Pre and Post Attitude Toward Their Students

| | Component/Section | | | |
|---|---|---|---|---|
| | UC | UGS/ES | UGS/PS | Total |
| t-Value | .95 | -.39 | -1.4[illegible] | -.13 |
| Degrees of Freedom | 11 | 7 | 7 | 27 |
| Minimum t-value to be significant at $p < .01$ | 3.11 | 3.50 | 3.50 | 2.77 |

Attitudes toward several aspects of science were assessed using the Semantic Differential Test in Science developed by Dr. James Gallagher of the Educational Research Council of America. This instrument was developed for use with the Test Every Senior Project. The Semantic Differential Test in Science was used in assessing the attitudes of Comprehensive Program participants both pre- and post-program.

The concepts evaluated by teachers were: (1) Mathematics, (2) Science, (3) Science Teaching, (4) Teachers, (5) School, (6) Laboratory Work, (7) Scientists and (8) Myself. These eight concepts were evaluated in terms of sixteen bi-polar scales. The bi-polar scales were classified into four categories--evaluation, potency, activity, and personality. A five-point differential was used on all scales. The vocabulary of the differential is found in Appendix 7, Table 3, p. 68.

Teacher responses to each of the semantic differential concepts were assigned integral values ranging from one point for the least favorable response (e.g. bad) to five points for the most favorable response (e.g. good). Since each of the categories, evaluation, potency, activity, and personality was comprised of four bi-polar scales, an average score for each category was determined for each individual. Thus, on each concept, a teacher (participant) received four scores ranging from one to five points, one score for evaluation, one for potency, one for activity, and one for personality. This was done on each participant previous to participation in the program and at the completion of participation. Group means were calculated for each Program Component.

For the purpose of this report the four concepts evaluated were: (1) Mathematics, (2) Science, (3) Science Teaching, and (4) Laboratory Work. Means and standard deviations for the Semantic Differential may be found in Appendix 4, beginning on p. 52.

a. Mathematics

Table II-10 provides information which shows no significant changes in attitudes toward mathematics by participants in the program components. The participants came into the program with fairly positive attitudes toward mathematics, and left the program with very much the same attitudes as shown by the means in Appendix 4, Tables 1 and 2, p. 52.

TABLE II-10

t-Tests for Matched Pairs Comparing Semantic Differential: Mathematics Pre- and Posttest Scores Grouped by Program Component/Sections

| | Component/Section | | | | |
|---|---|---|---|---|---|
| | UC<br>t | UGS/ES<br>t | UGS/PS<br>t | AY/B<br>t | AY/C<br>t |
| Evaluation | .84 | .75 | .14 | .43 | .00 |
| Potency | - .69 | 1.77 | .44 | .94 | .00 |
| Activity | - .55 | -1.01 | - .09 | 1.24 | - .55 |
| Personality | - .49 | .00 | - .72 | .38 | - .55 |
| Degrees of Freedom | 16 | 16 | 16 | 11 | 2 |
| Minimum t-value to be significant at $p \geq .01$ | 2.92 | 2.92 | 2.92 | 3.11 | 9.93 |

b. Science

No significant changes (Table II-11) in participants' attitudes toward science were found when pre- and posttest scores on the Semantic Differential Test in Science were compared. However, a trend toward participants expressing a generally lower attitude toward science following program participation was noted in the CHEMS component, particularly in the potency category. Looking at the overall picture, it appears as though participants entered the program with positive attitudes toward science and these attitudes apparently remained quite positive. The means showing this are in Appendix 4, Tables 3 and 4, p. 53.

TABLE II-11

t-Tests For Matched Pairs Comparing Semantic Differential: Science Pre- and Posttest Scores Grouped by Program Component/Sections

| | Component/Section | | | | |
|---|---|---|---|---|---|
| | UC | UGS/ES | UGS/PS | AY/B | AY/G |
| | t | t | t | t | t |
| Evaluation | - .80 | .70 | -1.61 | -1.17 | -1.51 |
| Potency | -2.89 | .73 | -1.21 | .07 | 1.00 |
| Activity | -1.65 | - .51 | -1.11 | .54 | - .36 |
| Personality | -1.08 | - .78 | - .82 | .18 | -1.00 |
| Degrees of Freedom | 16 | 16 | 16 | 11 | 2 |
| Minimum t-value to be significant at $p < .01$ | 2.92 | 2.92 | 2.92 | 3.11 | 9.93 |

c. Science Teaching

Table II-12 provides information which shows no significant changes in attitudes toward science teaching by participants in the program components. It should be noted, however, that participants in the Physical Science Section of the General Science Component exhibited a trend toward expressing generally lower attitudes toward Science Teaching following program participation. Again, it should be pointed out that participants came into the program with positive attitudes toward science teaching, and left the program with very much the same attitudes as shown by the means in Appendix 4, Tables 5 and 6, p. 54.

TABLE II-12

t-Tests for Matched Pairs Comparing Semantic Differential: Science Teaching Pre- and Posttest Scores Grouped by Program Component/Sections

| | Component/Section | | | | |
|---|---|---|---|---|---|
| | UC t | UGS/ES t | UGS/PS t | AY/B t | AY/C t |
| Evaluation | -1.10 | 1.41 | -1.54 | .35 | -1.73 |
| Potency | -2.46 | 2.55 | -2.70 | .00 | - .50 |
| Activity | .00 | .49 | -2.58 | - .42 | -1.89 |
| Personality | -1.22 | - .86 | -2.21 | - .69 | .00 |
| Degrees of Freedom | 16 | 16 | 16 | 11 | 2 |
| Minimum t-value to be significant at p ≤ .01 | 2.92 | 2.92 | 2.92 | 3.11 | 9.93 |

d. Laboratory Work

Table II-13 provides information which shows no significant changes in attitudes toward lab work by participants in the program components. In general, it should be concluded that participants held a relatively positive attitude toward lab work both prior to and following program participation. The means showing this are in Appendix 4, Tables 7 and 8, p. 55.

TABLE II-13

t-Test for Matched Pairs Comparing Semantic Differential: Lab Work Pre- and Posttest Scores Grouped By Program Component/Sections

| | Component/Section | | | | |
|---|---|---|---|---|---|
| | UC<br>t | UGS/ES<br>t | UGS/PS<br>t | AY/B<br>t | AY/C<br>t |
| Evaluation | -.84 | .00 | -.51 | -2.28 | -2.00 |
| Potency | -.75 | 1.77 | .89 | -.66 | .23 |
| Activity | .72 | -.82 | -.58 | -1.08 | .28 |
| Personality | -.45 | 1.97 | -1.24 | -1.20 | -2.00 |
| Degrees of Freedom | 16 | 16 | 16 | 11 | 2 |
| Minimum t-value to be significant at $p \leq .01$ | 2.92 | 2.92 | 2.92 | 3.11 | 9.93 |

2. Participants' Students

Attitudes toward several aspects of science were assessed using the Semantic Differential Test in Science developed by Dr. James Gallagher of the Educational Research Council in America. This instrument was developed for use with the Test Every Senior Project. The Semantic Differential Test in Science was used in assessing the attitudes of Comprehensive Program participants' students both pre- and post-program.

The concepts evaluated by these students were: (1) Mathematics, (2) Science, (3) Science Teachers, (4) Teachers, (5) School, (6) Laboratory Work, (7) Scientists, (8) Myself. These nine concepts were evaluated in terms of sixteen bi-polar scales. The bi-polar scales were classified into four categories--evaluation, potency, activity, and personality. A five point differential was used on all scales. The differential vocabulary is found in Appendix 7, Table 3, p. 68.

Student responses to each of the semantic differential concepts were assigned integral values ranging from one point for the least favorable response (e.g. bad) to five points for the most favorable response (e.g. good). Since each of the categories, evaluation, potency, activity, and personality was comprised of four bi-polar scales, an average score for each category was determined for each individual. Mean category scores were calculated for all the students of any one teacher.

Thus, on each concept a participant received four scores for his students ranging from one to five points, one score for evaluation, one for potency, one for activity, and one for personality. This was done for each participant previous to participation in the program and at the completion of participation. Group means were calculated for each Program Component.

For the purpose of this report the four concepts evaluated were: (1) Mathematics, (2) Science, (3) Science Teachers, and (4) Laboratory Work. Means and standard deviations for the Semantic Differential may be found in Appendix 4 beginning on p. 56.

a. Mathematics

Table II-14 provides information which indicates that CHEMS participants' students' attitudes toward mathematics did not change significantly following their teacher's completion of the CHEMS component.

Table II-14 provides information which indicates no significant change in Earth Science participants' students' attitudes toward mathematics following their teacher's completion of the General Science Component.

Physical Science participants' students had changed their attitudes significantly ($p < .01$ level) toward mathematics (potency category) following their teacher's completion of the component (Table II-14). This change was toward more positive attitudes in the potency category.

TABLE II-14

t-Tests for Matched Pairs Comparing Student Semantic Differential: <u>Mathematics</u> Pre- and Posttest Scores Grouped by Program Component/Sections

| | Component/Section | | |
|---|---|---|---|
| | UC t | UGS/ES t | UGS/PS t |
| Evaluation | 2.81 | 2.08 | 3.08 |
| Potency | 1.22 | 1.43 | 4.43 ! |
| Activity | .81 | 1.94 | 3.05 |
| Personality | .79 | 1.38 | 2.86 |
| Degrees of Freedom | 11 | 6 | 7 |
| Minimum t-value to be significant at $p \leq .01$ | 3.11 | 3.71 | 3.50 |

b. Science

No significant changes (Table II-15) in participants' students' attitudes toward science were found when pre- and posttest scores on the Semantic Differential Test in Science were compared. However, a general trend in the positive direction seems to emerge in the Physical Science Component.

TABLE II-15

t-Tests for Matched Pairs Comparing Student Semantic Differential: Science Pre- and Posttest Scores Grouped by Program Component/Sections

| | Component/Section | | |
|---|---|---|---|
| | UC | UGS/ES | UGS/PS |
| | t | t | t |
| Evaluation | .24 | .70 | 2.26 |
| Potency | -.94 | .22 | 2.74 |
| Activity | -.26 | 1.56 | 1.59 |
| Personality | -.57 | -.89 | 1.65 |
| Degrees of Freedom | 11 | 6 | 7 |
| Minimum t-value to be significant at $p \leq .01$ | 3.11 | 3.71 | 3.50 |

c. Science Teachers

Table II-16 provides information which shows no significant changes in attitudes toward science teachers by participants' students following their teachers' completion of the Comprehensive Program Components.

TABLE II-16

t-Tests for Matched Pairs Comparing Student Semantic Differential: Science Teachers Pre- and Posttest Scores Grouped By Program Component/Sections

| | Component/Section | | |
|---|---|---|---|
| | UC | UGS/ES | UGS/PS |
| | t | t | t |
| Evaluation | - 1.44 | .48 | 1.68 |
| Potency | - 1.69 | .15 | 1.49 |
| Activity | - 1.71 | .62 | 1.80 |
| Personality | - 1.47 | .54 | 2.73 |
| Degrees of Freedom | 11 | 6 | 7 |
| Minimum t-value to be significant at $p \leq .01$ | 3.11 | 3.71 | 3.50 |

d. Laboratory Work

Table II-17 provides information which indicates no significant change in CHEMS or Earth Science participants' students' attitudes toward lab work following their teacher's completion of these components.

TABLE II-17

t-Test for Matched Pairs Comparing Student Semantic Differential: Lab Work Pre- and Posttest Scores Grouped By Program Component/Sections

| | Component/Section | | |
|---|---|---|---|
| | UC | UGS/ES | UGS/PS |
| | t | t | t |
| Evaluation | - .35 | .88 | 1.83 |
| Potency | -1.17 | - .44 | 4.17 ! |
| Activity | - .04 | .94 | 1.65 |
| Personality | -2.50 | .53 | 2.14 |
| Degrees of Freedom | 11 | 6 | 7 |
| Minimum t-value to be significant at $p \leq .01$ | 3.11 | 3.71 | 3.50 |

The Physical Science participants' students had changed their attitudes significantly ($p < .01$ level) toward lab work (potency category) following their teacher's completion of the component (Table II-17). The change was toward more positive attitudes in the potency category. None of the other categories showed significant change.

III. PROGRAM PROCESS EVALUATION

Questionnaires were developed which obtained information relative to the operation of the overall program and relative to the specific components. Information will be presented and discussed relative to the total program operation, but will also include discussion of specific components as it is needed. In general, a distinction will be made between information pertaining to the Academic Year Institutes and information related to the Unitary Components.

Data was collected from all participants in Unitary Components (N=53). It was also collected from AY participants (N=14). The total number of respondents that provided data for this section was 67.

A. Information Prior to Arrival in Vermillion

1. Sources of information about program at U.S.D.

Approximately 39% of the participants received their information concerning the program from the brochure sent out by the University. About 21% received their information from the NSF brochure. The rest received their information from co-workers, previous participants, and other miscellaneous sources.

2. Number of institutes applied and acceptances

The mean number of institutes applied to by participants was approximately two. The mean number of acceptances received was one.

3. Reason for choosing U.S.D.

The two primary reasons for choosing U.S.D. were the fact that participants wished to further their education at a University close to home and the fact that the University had accepted them into the program.

4. Adequacy of information for making judicious decisions about the institute

Ninety-five percent of the participants felt the information provided them was adequate.

5. Adequacy of information after accepting institute, with particular reference to housing, the community, and the University

Approximately 92% of the participants felt adequately informed about housing.

Approximately 95% felt adequately informed about Vermillion.

About 97% of the participants felt adequately informed about the University and the departments with which they would be working.

B. Participant and Institutional Commitment to Program

1. Could participants continue education without NSF assistance?

Thirty-three percent of the participants in both Unitary and Academic Year components indicated they could continue their education without NSF support.

2. Discussion of program participation with school administrators

About 79% of the Unitary participants and 92% of the AY participants discussed their institute participation with their school principal. Approximately 64% of the Unitary participants and 76% of the AY participants discussed their institute participation with their superintendent. Ninety-one percent of the Unitary participants indicated that their superintendent supported their attending the institute while only 70% of the AY participants felt their superintendent was in sympathy with their attendance.

3. Moral and/or financial support from the school system as a direct or indirect result of U.S.D. Comprehensive Program participation

About 83 percent of the Unitary participants indicated their schools would provide moral support for improving the science education program in their schools. Only 55% of the AY participants indicated that they anticipated such moral support.

Approximately 56% of the Unitary participants indicated their schools would provide financial support (equipment, materials, facilities, released time, etc.) for the improvement of the science education program in their schools. About 36% of the AY participants indicated that they anticipated such financial support.

Approximately 8% of the Unitary participants received collateral support from their school while participating in the Comprehensive Program. None of the AY participants received such collateral support.

C. Course Related Activities

1. Field trips as a part of the program

Sixty-seven percent of the Unitary participants and all of the AY participants were involved in field trips as a part of their program. On a scale of 1 to 4 the field trips received a mean rating of 3.21 which indicated that the participants felt the trips were quite successful. When the participants were asked whether field trips should be a part of the their institute program, 100% of the Unitary participants and 92% of the AY participants responded yes.

2. Desire more work with science course improvement project materials

Seventy-eight percent of the Unitary participants and 58% of the AY participants desire more work with science course improvement project materials. This indicates that based on their experiences with curricular materials at U.S.D., they would like more work of this kind. This response was particularly true of participants in Unitaries directed at familiarization with a particular curriculum project.

3. Desire more opportunities to work on teaching skills

Approximately 74% of the participants indicated they would like further opportunity to work on teaching skills such as questioning or those developed through microteaching.

4. Value of introductory courses with graduate credit

Almost all participants responded that the availability of introductory science courses which they could take for graduate credit had been very useful. They also felt that the offering of these courses should be continued. Only 20% of the AY participants felt that more introductory courses in addition to those already available should be offered.

5. Plans for pursuing further degrees

Sixty-five percent of the Unitary participants indicated that their plans were to pursue a degree beyond the one they currently held. About 63% of those who answered positively indicated that they planned on getting their degree from U.S.D.

6. Plans to do further graduate study at U.S.D.

Approximately 70% of the Unitary participants indicated that they planned to do further graduate study at U.S.D. Table III-1 provides information with reference to the specific subject matter areas in which these participants plan to do their graduate work.

7. Adequacy of counsel and guidance from departments

Eighty-three percent of the AY participants indicated that they felt they had received adequate counsel and guidance from their major department. Approximately 91% felt they had received adequate counsel and guidance from their minor department and the Office of the Director. Questions regarding counsel and guidance from departments was not asked of participants in Unitary Components.

8. Availability of pre-arrival counsel and guidance

All AY participants indicated that pre-arrival counsel and guidance were available from their major department. Approximately 55% stated that pre-arrival counsel and guidance were available from their minor departments.

9. The necessity of pre-arrival counsel and guidance

Seventy-five percent of the AY participants felt that pre-arrival counsel and guidance from their major department had been necessary. Only about 27% felt that such counsel and guidance was necessary from their minor departments.

TABLE III-1

Frequencies of Subject Matter Areas in Which Unitary Participants Plan to Do Further Graduate Work

| Subject | Frequency |
|---|---|
| Biology | 11 |
| Chemistry | 7 |
| Mathematics | 4 |
| Administration | 3 |
| Physics | 2 |
| Astronomy | 1 |
| Meteorology | 1 |
| Physical Education | 1 |
| Undecided | 7 |
| Total | 37 |

10. Is the degree a crucial part of the program?

The question as to whether the degree was a crucial part of their program was posed to AY participants only. Approximately 92% of these participants indicated the degree was crucial.

11. Are short workshops of value?

Approximately 92% of the AY participants felt that short workshops such as the ones held in ISCS, ESS, SCIS, and S-APA were of value.

12. Participants awareness of preservice teachers participating in their institute programs

This question was asked only of participants in the Unitary Components. Approximately 75% of these participants were aware of the fact that there were preservice (prospective teachers without teaching experience) teachers participating in their institute program.

D. Housing

1. Did participants live in Vermillion?

This question was answered only of AY participants. Approximately 83% of these participants lived in Vermillion.

2. Type of Housing

Unitary Institute participants were found to occupy five of the six different types of housing indicated on the questionnaire. The majority of them, however, resided in either University housing (57%) or apartments in town (24%).

AY Institute participants were found to occupy four of the six different types of housing indicated on the questionnaire. The majority of them resided in either trailer parks (58%) or motel apartments (25%).

3. Adequacy of housing for participants' needs

About 96% of the Unitary participants and all of the AY participants felt that housing was adequate to meet their needs.

4. Number of dependents per participant

This question was answered only by participants in the Unitary Components. The mean number of dependents per Unitary participant was approximately 2.22.

5. Participants' recommendations of housing for future program participants

Approximately 95% of the Unitary participants and 92% of the AY participants indicated that they would recommend the housing they had utilized for use by future program participants with the same number of dependents.

6. Amount paid for rent

Unitary participants paid an average of $90.00 a month rent and most of them did not pay their own utilities. AY participants, on the other hand, paid an average of $105.00 a month rent and most of them did pay their own utilities.

E. Adequacy of Community Resources

1. Adequacy of local businesses to meet participants' needs

Approximately 94% of the Unitary participants and 75% of the AY participants felt that local businesses were adequate to meet their needs.

2. Adequacy of eating establishments

About 39% of the Unitary participants indicated that they normally ate at home, 25% ate at local restaurants, and 35% ate at the student union. Of the AY participants, 92% ate at home and 8% ate in the student union.

3. Adequacy of community activities to meet the needs of the participants' children

All of the Unitary participants who had children with them felt the community adequately met the needs of their children. Approximately 86% of the AY participants who had children with them felt the community adequately met the needs of their children.

4. Adequacy of community activities to meet the needs of the participants and their wives

About 95% of the Unitary participants indicated that community activities were adequate to meet their needs and the needs of their wives. All of the AY participants indicated that such activities were adequate for themselves and their wives.

5. Rating on how pleased the participants were with the way they and their family had been treated in the community
(Rating: 4=extremely pleased, 3=quite pleased, 2=somewhat pleased, 1=not pleased)

The mean rating for Unitary participants was approximately 3.21 and the mean rating for AY participants was 2.80. Both groups indicated, in essence, that they were quite pleased with the way they had been treated in the community.

F. Activities Related to the NSF-USD Program

1. Ratings of Comprehensive Programs

Participants of the various program components were asked to rate the program they were participating in on a scale of 1 poor to 7 excellent.

All components except the Earth Science Section of the General Science Component received greater than a six rating on a seven point scale. The ratings by institute were CHEMS = 6.53, General Science/Earth Science Section = 5.89, General Science / Physical Science Section = 6.13, AY Component = 6.17.

2. Adequacy of institute social activities for participants and their families

All participants felt that the institute social activities were adequate for their needs. Approximately 84% of the Unitary participants and all of the AY participants felt that institute social activities were adequate for their families.

3. Adequacy of opportunity for participants to interact with students in other programs

Approximately 53% of the people in CHEMS and 80% of the participants in the General Science Component felt they had adequate opportunity to interact with participants from other programs. Seventy-five percent of the AY participants indicated that such opportunities had been adequate.

4. Adequacy of opportunity for participants to interact with undergraduate students

This question was asked only of AY participants. Sixty-seven percent of these participants felt that they had an adequate opportunity to interact with undergraduate students. About 83% felt that this kind of interaction would be of advantage to them and 80% felt that such interactions would be of benefit to undergraduate students.

5. Participants' understanding of program evaluation

Approximately 88% of the Unitary participants and all of the AY participants indicated they understood the reasons for the over-all program evaluation.

6. Value of program evaluation

About 85% of the Unitary participants and all of the AY participants felt the program evaluation was worthwhile.

7. Time involved in program evaluation

Approximately 25% of the Unitary participants and none of the AY participants felt that too much time was involved in program evaluation. The most frequent complaint was against the amount of classroom time required for collecting data from their students.

8. Collecting data from participants' students and the adequacy of directions for collecting data from participants' students

This question was asked only of Unitary institute participants. Approximately 92% of these participants indicated that they had no difficulty in collecting the data from their students. About 91% of these participants felt the directions they used for collecting data from their students were adequate.

G. Miscellaneous Information

1. Do participants return to the school they taught at prior to program participation?

Eighty-seven percent of the participants completing the Unitary Program returned to the school they taught at prior to program participation. Only about eight percent of the AY participants returned to the school they taught at prior to program participation.

2. What subjects, grade levels, and in what size schools do participants desire to teach?

Participants were asked to respond to the question, "What subjects, what grade level(s), and in what size schools they would teach if they had complete choice in the matter and salary was not a factor?" Information on this question will be presented under each program component.

a) CHEMS Component

Seventy-one percent of the CHEMS participants would like to teach chemistry or some combination of subjects including chemistry. There was no one particular subject which was picked more frequently as a companion when participants listed more than one subject.

Eighty-eight percent of the CHEMS participants would choose to work at least some of the day with students of tenth grade level or above. Approximately 60% indicated that they preferred to work exclusively with tenth grade students or older.

The CHEMS participants would prefer, on the average, to teach in schools with enrollments of 600 students.

b) General Science Components

Approximately eighty percent of the General Science participants indicated they would like to continue teaching general science or some combination of subjects which included general science. Mathematics was the most frequent companion (17%) when participants listed more than one subject.

Approximately 82% of the General Science participants would choose to work at least some of the day with students ninth grade level or below. Approximately 65% indicated they would prefer to work exclusively with these younger students.

The General Science participants, if given their choice, would choose to work in schools having student enrollments of approximately 700 students. Further analysis reveals that those in the Earth Science Section prefer an average school size of 875 students, whereas the participants in the Physical Science section prefer, on the average, a school of about 535 students.

c) AY Components

The Biology AY participants all indicated that they preferred to teach biology. Approximately 85% of the Chemistry AY participants indicated that they preferred to teach chemistry or chemistry plus some other subject. The number of participants for which we have this type of data is too small, however, to make a strong generalization.

Almost all AY participants indicate they would prefer to teach at least some of the day with students at grade levels 10 through 12. Approximately 75% indicated that they preferred to work exclusively with tenth grade students or older.

The AY participants would prefer, on the average, to teach in schools with enrollments of 875 students.

## IV. SUMMARIES AND CONCLUDING REMARKS

### A. Summary of the 1972-73 Comprehensive Program.

Data were collected and analyzed related to the following four primary areas.

a) Descriptive Information of Participants

b) Descriptive Information of Participants' Students

c) Evaluation of Program Objectives

d) Program Process Evaluation

Some major points discerned from the areas were:

1. The Comprehensive Program was a truly regional program.

2. Participants in the program normally teach more than one science subject and at more than one grade level. Many of the participants have at least some teaching responsibility at the junior high school level.

3. Students of the participants hold a moderately positive view of science and their science course (about 3 on a 5 point scale, indicating they 'sometimes' like science or their science course).

4. The participants' students hold a strong "I don't know" attitude when asked if they would take more science courses or if they plan to go into a science related career.

5. The participants enjoy teaching science and they like the students they teach.

6. Participants in all programs where data were available showed significant progress in subject matter competency by the completion of the program.

7. The participants entered the program in generally good agreement with science educators as to the types of classroom and laboratory activities which should be used for secondary school science instruction. The program components, in general, contributed positively toward strengthening this agreement.

8. The nature of the participants' classroom and laboratory activities which they use in their schools were approximately 56% in agreement with science educators. This was measured through the eyes of their students.

9. The participants ranked near the 90th percentile in their understanding of science when compared to the 1960 national sample of twelfth grade students following their program participation.

10. The participants' students ranked near the 26th percentile in their understanding of science when compared to the 1960 national sample of twelfth grade students. The students in this study, though, were primarily in grades 9-11; when compared to the 9th grade national sample their average was at the 35th percentile.

11. In general, participants were pleased with their respective program components, The University of South Dakota, and the City of Vermillion.

B. Overall Summary of the Objectives and Conclusions Relating to the Objectives for 1971-72 and 1972-73

The conclusions relating to the objectives of the program as established in 1971 are the following: (The objectives are listed in the order of importance as rated by the participants in the 1971-72 Institutes.)

a) To increase the subject matter competency of the participants.

The subject matter competency clearly rose significantly in all the components for each year the program was operational.

b) Contribute toward participants using science instructional activities consistent with contemporary objectives of science education.

The Science Classroom Activities Checklist - Teacher Perceptions and Student Perceptions - scores did not change significantly after program participation for 1971-72 or 1972-73. Some positive changes were noted in specific subscales; these are recorded in the reports.

c) Contribute toward the implementation of newer curricular materials in the participants' schools.

Participants received an increase in resources (materials, facilities, released time) which was made available to them as a result of program participation. Significant increase (with specific adoptions) in the use of national curricular project materials was not observed.

d) To encourage the exchange of ideas, concepts, and goals between institute participants.

In general, the participants felt they had adequate time to engage in this type of activity. Quantitative and qualitative dimensions of this questionwere not investigated.

e) To develop in the participants an understanding of the nature of science.

The participants ranked quite high in the Test on Understanding Science in all components both years. They ranked at the 90th percentile when compared to the 1960 national sample of twelfth grade students.

f) To encourage the exchange of ideas, concepts, and goals between experienced and pre-service teachers.

Interchange did occur but it was not evaluated quantitatively or qualitatively.

g) Contribute toward the development of teachers who will motivate secondary school students toward careers in science, science teaching, and related careers such as engineering and medicine.

The questions assumed to measure a change toward fulfilling this objective were the questions directed toward the participants' students, asking:

Do you like science?

Do you like the science course you are currently taking?

Do you plan to take any more science courses?

Do you plan to go into a science related career?

There was no change in student responses after their teacher had participated in the Comprehensive Program when compared to student responses who had been taught prior to institute participation.

h) Result in participants completing an MNS degree.

When asked about the necessity of receiving graduate credit for program participation, 92% of the Academic Year Institute participants (this was the only institute which the question was asked of) indicated the credit was a valuable part of the program.

100% of the Sequential Institutes of the 1971 summer (ending in the 1972 summer) indicated the MNS degree was a crucial part of the program. This institute was the only one which received the question.

i) To develop in teachers an understanding of how science related to society (past, present, and future).

This was measured in subscale 1 of the <u>Test on Understanding Science</u> - The Scientific Enterprise. There was no significant difference either year, although a non-significant positive gain ($p > .01$) showed in all components of 1971-72 and the Unitary General Science Component of the 1972 summer.

j) To develop in participants a basic proficiency in Mathematics.

The Unitary General Science participants did gain significantly in their proficiency with mathematics necessary for teachers who would teach the curricular materials emphasized in this component. This was the only component in which mathematics competency was specifically taught for and evaluated.

Concluding Statement

The primary aim of each component of the Comprehensive Project during the years 1970-73 was to develop the subject matter and mathematics competencies required to teach modern science courses. There is evidence that this was accomplished. Changes in behaviors and attitudes of participants and their students, as a result of teachers' program participation, is equivocal.

As a result of this evaluation and our experience in the Comprehensive Project, the USD program focus has been changed to be a much more direct collaborative effort with school districts of the region. This involves creating awareness of newer curricular materials, helping districts with adoption decisions, and then assisting with implementation. We feel this direct collaborative effort will have considerable regional impact.

One word of caution should be given. Subject matter competency is an important undergirding structure to teaching. Renewing subject matter should be a part of the continuous process of teacher renewal and should not be ignored in association with the direct emphasis on materials implementation. To ignore this important area will simply ensure that at some future date a crash program will have to be developed to upgrade teachers' subject matter competencies. It would seem that an understanding of past history would provide the wisdom to prevent falling into this trap.

APPENDICES

Index of Appendices

## APPENDIX 1

### TABLE 1

Means, Standard Deviations and t-Test for Matched Samples Comparing USD General Mathematics Test Pre- and Post-test Scores

Earth Science Participants

| | Pretest (n=14) | | Posttest (n=14) | | Pretest-Posttest |
|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | t |
| Test Scores (50 possible) | 30.07 | 8.69 | 40.57 | 4.94 | 7.15* |
| Degrees of Freedom | | | | | 13 |

*t ≥ 3.01 to be significant at the .01 level

### TABLE 2

Means, Standard Deviations and t-Test for Matched Samples Comparing USD General Mathematics Test Pre- and Post-test Scores

Physical Science Participants

| | Pretest (n=17) | | Posttest (n=12) | | Pretest-Posttest |
|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | t |
| Test Scores (50 possible) | 33.59 | 10.63 | 37.25 | 7.30 | 6.32* |
| Degrees of Freedom | | | | | 11 |

*t ≥ 3.11 to be significant at the .01 level

### TABLE 3

Means, Standard Deviations, and t-Test for Matched Samples Comparing Test of Earth Science Knowledge Pre- and Post-test Scores

Earth Science Participants

| | Pretest (n=16) | | Posttest (n=17) | | Pretest-Posttest |
|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | t |
| Test Scores (69 possible) | 48.88 | 7.08 | 53.06 | 5.71 | 6.77* |
| Degrees of Freedom | | | | | 15 |

* t ≥ 2.95 to be significant at the .01 level

TABLE 4

Means, Standard Deviations, and t-Test for Matched Samples Comparing Physical Science Pre- and Post-test Scores

Physical Science Participants

| | Pretest (n=18) | | Posttest (n=18) | | Pretest-Posttest |
|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | t |
| Test Scores (56 possible) | 30.50 | 7.30 | 46.56 | 6.88 | 9.53* |
| Degrees of Freedom | | | | | 17 |

*$t \geq 2.90$ to be significant at the .01 level

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TABLE 5

Pretest and Posttest Means and Standard Deviations for Subscales and Composite Scores on the USD Graduate Biology Examination

| | AY Biology Pretest (n=11) | | AY Biology Posttest (n=12) | | Pretest-Posttest (n=11) |
|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | t |
| Animal Anatomy and Development (20 possible) | 11.73 | 2.80 | 12.17 | 3.51 | .11 |
| Plant Morphology and Anatomy (20 possible) | 11.64 | 2.38 | 14.08 | 3.73 | 2.47 |
| Genetics (20 possible) | 10.00 | 3.58 | 10.42 | 3.34 | .23 |
| Cell Physiology (20 possible) | 12.18 | 2.96 | 12.83 | 3.07 | .41 |
| Ecology (20 possible) | 9.09 | 2.44 | 11.04 | 3.39 | 1.65 |
| General Biology (25 possible) | 16.82 | 3.76 | 17.83 | 3.33 | .7[illegible] |
| Composite (125 possible) | 71.77 | 13.41 | 78.38 | 16.12 | 1.56 |
| Degrees of Freedom | | | | | 10 |

$t \geq 3.17$ to be significant at the .01 level

TABLE 6

Pretest and Posttest Means and Standard Deviations on the Chemistry Department Examination

AY Chemistry Participants

| | Pretest (n=4) | | Posttest (n=3) | | Pretest-Posttest (n=3) |
|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | t |
| Test Scores (47 possible) | 11.50 | 3.00 | 15.67 | 3.79 | 2.00* |
| Degrees of Freedom | | | | | 2 |

* $t \geq 9.93$ to be significant at the .01 level

APPENDIX 2

TABLE 1

Pre- and Posttest Means and Standard Deviations for Subscales and Composite Scores on the SCACL:TP by Program Component Sections and Total Program

Component/Section

| SCACL:TP | UC (pre n=17) (post n=17) | | UGS/ES (pre n=16) (post n=17) | | UGS/PS (pre n=17) (post n-18) | | AY/B (pre n=12) (post n=11) | | AY/C (pre n=4) (post n=3) | | Total (pre n=66) (post n=66) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Subtest A Pretest 8* | 6.94 | .90 | 7.19 | .91 | 7.18 | .64 | 7.33 | .78 | 7.50 | .58 | 7.17 | .80 |
| Subtest A Posttest 8* | 7.35 | .61 | 7.35 | .61 | 7.17 | .79 | 7.27 | 1.01 | 8.00 | .00 | 7.32 | .73 |
| Subtest B Pretest 9* | 7.65 | 1.41 | 8.50 | .73 | 8.41 | .71 | 8.08 | .79 | 7.00 | 1.83 | 8.09 | 1.09 |
| Subtest B Posttest 9* | 8.12 | .78 | 8.35 | .86 | 8.67 | .59 | 8.27 | 1.27 | 8.67 | .58 | 8.35 | .86 |
| Subtest C Pretest 8* | 6.88 | .93 | 6.88 | 1.03 | 7.12 | .93 | 7.24 | .87 | 7.75 | .50 | 7.06 | .93 |
| Subtest C Posttest 8* | 6.94 | 1.09 | 6.77 | 1.09 | 7.44 | .92 | 6.72 | .79 | 7.67 | .58 | 7.03 | 1.01 |
| Subtest D Prestest 11* | 9.47 | 1.18 | 8.94 | 1.53 | 9.00 | 1.37 | 8.92 | 1.24 | 9.25 | 1.71 | 9.11 | 1.34 |
| Subtest D Posttest 11* | 9.06 | 1.25 | 8.94 | 1.58 | 9.61 | 1.42 | 9.18 | 1.47 | 10.67 | .58 | 9.27 | 1.45 |
| Subtest E Pretest 8* | 6.94 | .83 | 6.19 | 1.42 | 6.53 | .72 | 6.50 | 1.24 | 6.75 | 1.26 | 6.56 | 1.08 |
| Subtest E Posttest 8* | 6.82 | 1.02 | 6.65 | 1.17 | 6.56 | .92 | 6.27 | 1.10 | 7.00 | .00 | 6.62 | 1.02 |
| Subtest F Pretest 9* | 7.35 | 2.03 | 7.31 | 1.40 | 7.82 | 1.07 | 7.33 | 1.16 | 7.25 | 1.50 | 7.45 | 1.46 |
| Subtest F Posttest 9* | 7.47 | .94 | 7.59 | 1.62 | 7.78 | 1.44 | 7.46 | .93 | 8.00 | 1.00 | 7.61 | 1.26 |
| Subtest G Pretest 7* | 6.05 | 1.68 | 6.56 | .51 | 6.29 | .69 | 6.67 | .65 | 7.00 | .00 | 6.51 | 1.01 |
| Subtest G Posttest 7* | 6.47 | .72 | 6.65 | .49 | 6.94 | .24 | 6.64 | .67 | 7.00 | .00 | 6.70 | .55 |
| Composite Pretest 60* | 51.41 | 6.58 | 51.50 | 5.47 | 52.35 | 4.11 | 52.25 | 4.25 | 52.50 | 6.61 | 51.90 | 5.19 |
| Composite Posttest 60* | 52.24 | 3.40 | 52.18 | 5.43 | 54.33 | 4.07 | 51.82 | 4.14 | 57.00 | 1.73 | 52.94 | 4.36 |

*The highest score possible.
Subtest A - Student Classroom Participation
Subtest B - Role of the Teacher in the Classroom
Subtest C - Use of Textbook and Reference Materials
Subtest D - Design and Use of Tests
Subtest E - Laboratory Preparation
Subtest F - Types of Laboratory Activities
Subtest G - Laboratory Follow-Up Activities

TABLE 2

Pre- and Posttest Means and Standard Deviations for Subscales and Composite Scores on the SCACL:SP By Separate Program Component/Sections and Total Program

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (pre n=14) (post n=12) | | UGS/ES (pre n=9) (post n=10) | | UGS/PS (pre n=11) (post n=10) | | Total (pre n=34) (post n=32) | |
| SCACL:SP | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Subtest A Pretest 8* | 4.28 | .66 | 4.06 | 1.40 | 4.60 | .83 | 4.33 | .95 |
| Subtest A Posttest 8* | 4.82 | .93 | 4.22 | .76 | 4.50 | .52 | 4.53 | .79 |
| Subtest B Pretest 9* | 5.13 | .63 | 5.21 | .88 | 5.12 | .63 | 5.15 | .69 |
| Subtest B Posttest 9* | 4.97 | .72 | 5.17 | .58 | 5.04 | .83 | 5.06 | .70 |
| Subtest C Pretest 8* | 4.48 | .71 | 4.30 | .84 | 4.66 | 1.09 | 4.49 | .86 |
| Subtest C Posttest 8* | 4.94 | .64 | 4.31 | .35 | 4.90 | .55 | 4.73 | .59 |
| Subtest D Pretest 11* | 6.20 | 1.28 | 5.43 | 1.06 | 5.04 | .70 | 5.62 | 1.15 |
| Subtest D Posttest 11* | 6.43 | 1.56 | 5.40 | .67 | 6.28 | 1.19 | 6.06 | 1.27 |
| Subtest E Pretest 8* | 4.70 | .66 | 4.80 | .49 | 4.56 | .58 | 4.68 | .58 |
| Subtest E Posttest 8* | 4.94 | 1.01 | 4.67 | .33 | 4.64 | .64 | 4.76 | .73 |
| Subtest F Pretest 9* | 4.69 | .68 | 4.15 | .98 | 4.77 | .90 | 4.57 | .85 |
| Subtest F Posttest 9* | 4.98 | .54 | 4.38 | .72 | 4.83 | .69 | 4.75 | .68 |
| Subtest G Pretest 7* | 3.91 | .72 | 3.99 | .93 | 4.18 | .92 | 4.02 | .83 |
| Subtest G Posttest 7* | 4.52 | 1.07 | 4.02 | .79 | 4.11 | .59 | 4.23 | .86 |
| Composite Pretest 60* | 33.74 | 4.19 | 32.41 | 4.83 | 33.12 | 3.70 | 33.19 | 4.12 |
| Composite Posttest 60* | 35.62 | 5.38 | 32.14 | 2.97 | 34.30 | 3.13 | 34.12 | 4.22 |

*Highest possible score

Subtest A - Student Classroom Participation
Subtest B - Role of the Teacher in the Classroom
Subtest C - Use of Textbook and Reference Materials
Subtest D - Design and Use of Tests
Subtest E - Laboratory Preparation
Subtest F - Types of Laboratory Activities
Subtest G - Laboratory Follow-Up Activities

APPENDIX 3

TABLE 1

Pre- and Posttest Means and Standard Deviations for the Teacher TOUS by Separate Program Component/Section and Total Program

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (pre n=17) (post n=17) | | UGS/ES (pre n=16) (post n=17) | | UGS/PS (pre n=17) (post n=18) | | AY/B (pre n=12) (post n=11) | | AY/C (pre n=4) (post n=3) | | Total (pre n=66) (post n=66) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| TOUS Subscale 1* Pretest | 14.29 | 2.11 | 13.56 | 2.56 | 11.12 | 2.67 | 13.58 | 2.47 | 14.50 | 1.73 | 13.18 | 2.67 |
| TOUS Subscale 1* Posttest | 14.12 | 2.57 | 14.38 | 2.19 | 12.56 | 2.77 | 13.09 | 3.27 | 15.00 | 1.00 | 13.55 | 2.72 |
| TOUS Subscale 2* Pretest | 13.24 | 2.41 | 13.25 | 1.77 | 11.88 | 2.06 | 11.58 | 1.78 | 12.75 | 4.35 | 12.56 | 2.27 |
| TOUS Subscale 2* Posttest | 13.41 | 2.43 | 14.06 | 1.53 | 12.44 | 3.01 | 10.73 | 3.10 | 14.33 | 1.16 | 12.80 | 2.79 |
| TOUS Subscale 3* Pretest | 16.18 | 3.47 | 16.38 | 2.19 | 12.59 | 3.16 | 14.50 | 2.84 | 15.50 | 3.70 | 14.95 | 3.31 |
| TOUS Subscale 3* Posttest | 15.77 | 3.87 | 16.94 | 2.89 | 13.89 | 3.60 | 15.00 | 3.49 | 16.33 | 3.51 | 15.36 | 3.58 |
| TOUS Composite** Pretest | 43.53 | 7.10 | 43.69 | 5.89 | 35.59 | 6.12 | 39.50 | 4.15 | 42.75 | 9.22 | 40.74 | 6.94 |
| TOUS Composite** Posttest | 43.29 | 7.75 | 45.44 | 5.18 | 38.72 | 6.83 | 38.82 | 9.00 | 45.67 | 4.73 | 41.68 | 7.64 |

*Possible 20 points
**Possible 60 points
Subscale 1 - The Scientific Enterprise
Subscale 2 - The Scientist
Subscale 3 - Methods and Aims of Science

TABLE 2

Pre- and Posttest Means and Standard Deviations for the Student TOUS by Separate Program Component/Sections and Total Program

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (pre n=13) (post n=12) | | UGS/ES (pre n=6) (post n=10) | | UGS/PS (pre n=8) (post n=10) | | Total (pre n=27) (post n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| TOUS Subscale 1* Pretest | 9.51 | 2.37 | 7.27 | .99 | 8.09 | .83 | 8.59 | 1.96 |
| TOUS Subscale 1* Posttest | 9.54 | 2.08 | 9.74 | 5.33 | 7.87 | 1.47 | 9.21 | 3.47 |
| TOUS Subscale 2* Pretest | 9.97 | 2.12 | 8.63 | .94 | 8.77 | 1.36 | 9.31 | 1.77 |
| TOUS Subscale 2* Posttest | 9.86 | 2.18 | 8.55 | 1.82 | 8.61 | 1.35 | 9.09 | 1.87 |
| TOUS Subscale 3* Pretest | 10.94 | 2.65 | 8.75 | 1.07 | 8.71 | 1.58 | 9.80 | 2.32 |
| TOUS Subscale 3* Posttest | 10.53 | 2.86 | 9.03 | 2.06 | 9.13 | 1.77 | 9.73 | 2.38 |
| TOUS Composite** Pretest | 30.40 | 6.76 | 24.62 | 2.56 | 25.57 | 3.49 | 27.69 | 5.74 |
| TOUS Composite** Posttest | 29.93 | 6.92 | 25.67 | 5.26 | 25.62 | 4.26 | 27.52 | 6.17 |

*Possible 20 points
**Possible 60 points
Subscale 1 - The Scientific Enterprise
Subscale 2 - The Scientist
Subscale 3 - Methods and Aims of Science

APPENDIX 4

TABLE 1

Means and Standard Deviations for Semantic Differential Pretest Scores: Mathematics Grouped by Program Component/Sections

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=17) | | AY/B (n=12) | | AY/C (n=4) | | Total (n=67) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.12 | .57 | 4.12 | .77 | 4.35 | .39 | 3.85 | .59 | 4.25 | .35 | 4.14 | .60 |
| Potency | 3.41 | .68 | 3.03 | .55 | 3.29 | .42 | 3.00 | .56 | 3.25 | .61 | 3.20 | .57 |
| Activity | 3.65 | .64 | 3.93 | .59 | 4.03 | .42 | 3.73 | .57 | 4.06 | .66 | 3.85 | .61 |
| Personality | 3.21 | .70 | 3.21 | .49 | 3.47 | .62 | 3.02 | .38 | 3.25 | .54 | 3.24 | .58 |

TABLE 2

Means and Standard Deviations for Semantic Differential Posttest Scores: Mathematics Grouped by Program Component/Sections

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=18) | | AY/B (n=12) | | AY/C (n=3) | | Total (n=67) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.22 | .50 | 4.21 | .73 | 4.39 | .59 | 3.92 | .42 | 4.42 | .29 | 4.22 | .58 |
| Potency | 3.34 | .68 | 3.25 | .60 | 3.36 | .54 | 3.15 | .63 | 3.42 | .63 | 3.31 | .61 |
| Activity | 3.59 | .57 | 3.74 | .75 | 4.01 | .60 | 3.92 | .55 | 4.00 | .25 | 3.82 | .62 |
| Personality | 3.13 | .56 | 3.21 | .42 | 3.32 | .55 | 3.06 | .56 | 3.25 | .25 | 3.19 | .51 |

TABLE 3

Means and Standard Deviations for Semantic Differential Pretest Scores: Science Grouped by Program Component/Sections

Component/Section

| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=17) | | AY/B (n=12) | | AY/C (n=4) | | Total (n=67) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.60 | .42 | 4.44 | .52 | 4.66 | .41 | 4.75 | .24 | 4.69 | .63 | 4.61 | .44 |
| Potency | 3.71 | .54 | 3.25 | .51 | 3.68 | .72 | 3.67 | .60 | 3.56 | .52 | 3.57 | .61 |
| Activity | 4.19 | .63 | 4.07 | .47 | 4.32 | .52 | 4.02 | .63 | 4.19 | .52 | 4.16 | .55 |
| Personality | 3.60 | .61 | 3.29 | .44 | 3.79 | .75 | 3.71 | .68 | 3.44 | .59 | 3.58 | .63 |

TABLE 4

Means and Standard Deviations for Semantic Differential Posttest Scores: Science Grouped by Program Component/Sections

Component/Section

| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=19) | | AY/B (n=12) | | AY/C (n=3) | | Total (n=67) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.50 | .56 | 4.51 | .53 | 4.54 | .40 | 4.50 | .45 | 4.67 | .38 | 4.54 | .47 |
| Potency | 3.47 | .61 | 3.34 | .50 | 3.49 | .68 | 3.69 | .68 | 3.83 | .52 | 3.50 | .61 |
| Activity | 4.01 | .70 | 4.01 | .62 | 4.21 | .63 | 4.08 | .62 | 4.17 | .29 | 4.09 | .62 |
| Personality | 3.46 | .66 | 3.21 | .30 | 3.63 | .76 | 3.75 | .72 | 3.42 | .38 | 3.49 | .63 |

TABLE 5

Means and Standard Deviations for Semantic Differential Pretest Scores: Science Teaching Grouped By Program Component/Sections

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=17) | | AY/B (n=12) | | AY/C (n=4) | | Total (n=67) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.66 | .40 | 4.40 | .47 | 4.56 | .44 | 4.44 | .34 | 4.81 | .24 | 4.54 | .42 |
| Potency | 3.53 | .51 | 3.07 | .49 | 3.50 | .59 | 3.56 | .51 | 3.63 | .75 | 3.42 | .56 |
| Activity | 4.04 | .51 | 4.18 | .49 | 4.38 | .47 | 4.19 | .49 | 4.44 | .66 | 4.21 | .50 |
| Personality | 3.79 | .63 | 3.63 | .70 | 4.06 | .64 | 3.79 | .68 | 4.00 | .54 | 3.83 | .65 |

TABLE 6

Means and Standard Deviations for Semantic Differential Posttest Scores: Science Teaching Grouped By Program Component/Section

| | Component/Sections | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=18) | | AY/B (n=12) | | AY/C (n=3) | | Total (n=67) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.56 | .48 | 4.53 | .42 | 4.40 | .61 | 4.48 | .53 | 4.42 | .38 | 4.49 | .50 |
| Potency | 3.32 | .47 | 3.28 | .55 | 3.28 | .51 | 3.56 | .64 | 3.75 | .50 | 3.36 | .54 |
| Activity | 4.04 | .54 | 4.24 | .51 | 4.11 | .53 | 4.10 | .61 | 4.33 | .52 | 4.13 | .53 |
| Personality | 3.60 | .52 | 3.51 | .66 | 3.69 | .78 | 3.67 | .69 | 3.75 | .25 | 3.62 | .64 |

TABLE 7

Means and Standard Deviations for Semantic Differential Pretest Scores: Lab Work Grouped by Program Component/Sections

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=17) | | AY/B (n=12) | | AY/C (n=4) | | Total (n=67) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.49 | .44 | 4.29 | .68 | 4.68 | .40 | 4.48 | .51 | 4.56 | .52 | 4.49 | .52 |
| Potency | 3.40 | .61 | 3.06 | .33 | 3.47 | .57 | 3.29 | .66 | 3.31 | .38 | 3.31 | .55 |
| Activity | 4.00 | .61 | 4.21 | .52 | 4.45 | .43 | 4.04 | .47 | 4.44 | .52 | 4.20 | .53 |
| Personality | 3.60 | .49 | 3.59 | .60 | 3.96 | .67 | 3.50 | .51 | 3.75 | .74 | 3.68 | .59 |

TABLE 8

Means and Standard Deviations for Semantic Differential Posttest Scores Lab Work Grouped by Program Component/Sections

| | Component/Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UC (n=17) | | UGS/ES (n=17) | | UGS/PS (n=18) | | AY/B (n=12) | | AY/C (n=3) | | Total (n=67) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 4.40 | .64 | 4.29 | .63 | 4.64 | .44 | 3.85 | 1.03 | 4.33 | .29 | 4.34 | .70 |
| Potency | 3.31 | .51 | 3.21 | .49 | 3.61 | .69 | 3.12 | .56 | 3.50 | .25 | 3.34 | .58 |
| Activity | 4.13 | .49 | 4.09 | .62 | 4.38 | .54 | 3.79 | .49 | 4.58 | .38 | 4.15 | .56 |
| Personality | 3.53 | .61 | 3.40 | .55 | 3.76 | .60 | 3.10 | .76 | 3.25 | .25 | 3.47 | .63 |

TABLE 9

Means and Standard Deviations for Student Semantic Differential Pretest Scores: Mathematics Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=14) | | UGS/ES (n=8) | | UGS/PS (n=11) | | Total (n=33) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.90 | .44 | 3.68 | .34 | 3.80 | .25 | 3.49 | .59 |
| Potency | 3.18 | .17 | 3.26 | .20 | 3.21 | .19 | 3.08 | .21 |
| Activity | 3.64 | .24 | 3.57 | .29 | 3.67 | .22 | 3.47 | .47 |
| Personality | 3.14 | .24 | 3.24 | .28 | 3.27 | .30 | 3.09 | .30 |

TABLE 10

Means and Standard Deviations for Student Semantic Differential Posttest Scores: Mathematics Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=12) | | UGS/ES (n=10) | | UGS/PS (n=10) | | Total (n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.90 | .44 | 3.68 | .34 | 3.80 | .25 | 3.80 | .36 |
| Potency | 3.18 | .17 | 3.26 | .20 | 3.21 | .19 | 3.21 | .18 |
| Activity | 3.64 | .24 | 3.57 | .29 | 3.57 | .22 | 3.63 | .25 |
| Personality | 3.14 | .24 | 3.24 | .28 | 3.27 | .30 | 3.21 | .27 |

TABLE 11

Means and Standard Deviations for Student Semantic Differential Pretest Scores: Science Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=14) | | UGS/ES (n=8) | | UGS/PS (n=11) | | Total (n=33) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.83 | .40 | 3.46 | .90 | 3.31 | .98 | 3.57 | .77 |
| Potency | 3.16 | .19 | 3.20 | .35 | 3.09 | .33 | 3.14 | .28 |
| Activity | 3.40 | .24 | 3.37 | .55 | 3.25 | .50 | 3.35 | .42 |
| Personality | 3.21 | .27 | 3.37 | .50 | 3.01 | .46 | 3.18 | .41 |

TABLE 12

Means and Standard Deviations for Student Semantic Differential Posttest Scores: Science Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=12) | | UGS/ES (n=10) | | UGS/PS (n=10) | | Total (n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.90 | .51 | 3.64 | .42 | 3.74 | .52 | 3.77 | .48 |
| Potency | 3.11 | .23 | 3.21 | .16 | 3.27 | .26 | 3.16 | .22 |
| Activity | 3.41 | .31 | 3.49 | .30 | 3.44 | .42 | 3.45 | .33 |
| Personality | 3.17 | .34 | 3.30 | .24 | 3.32 | .46 | 3.26 | .35 |

TABLE 13

Means and Standard Deviations for Student Semantic Differential Pretest Scores: Science Teachers Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=14) | | UGS/ES (n=8) | | UGS/PS (n=11) | | Total (n=33) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.76 | .48 | 3.51 | .84 | 3.34 | 1.06 | 3.56 | .80 |
| Potency | 3.23 | .51 | 3.16 | .42 | 3.06 | .49 | 3.16 | .47 |
| Activity | 3.68 | .37 | 3.46 | .76 | 3.35 | .81 | 3.52 | .64 |
| Personality | 3.85 | .45 | 3.52 | .89 | 3.25 | .96 | 3.57 | .78 |

TABLE 14

Means and Standard Deviations for Student Semantic Differential Posttest Scores: Science Teachers Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=12) | | UGS/ES (n=10) | | UGS/PS (n=10) | | Total (n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.61 | .70 | 3.69 | .36 | 3.65 | .56 | 3.65 | .30 |
| Potency | 3.15 | .37 | 3.24 | .31 | 3.25 | .42 | 3.21 | .13 |
| Activity | 3.59 | .33 | 3.65 | .34 | 3.61 | .43 | 3.62 | .13 |
| Personality | 3.78 | .51 | 3.81 | .41 | 3.71 | .52 | 3.77 | .22 |

TABLE 15

Means and Standard Deviations for Student Semantic Differential Pretest Scores: Lab Work Grouped By Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=14) | | UGS/ES (n=8) | | UGS/PS (n=11) | | Total (n=33) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.92 | .30 | 3.54 | 1.01 | 3.67 | .95 | 3.74 | .75 |
| Potency | 3.15 | .17 | 3.24 | .29 | 3.12 | .23 | 3.16 | .22 |
| Activity | 3.73 | .29 | 3.55 | .71 | 3.56 | .63 | 3.63 | .53 |
| Personality | 3.34 | .21 | 3.37 | .49 | 3.24 | .48 | 3.32 | .38 |

TABLE 16

Means and Standard Deviations for Student Semantic Differential Posttest Scores: Lab Work Grouped by Program Component/Sections

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (n=12) | | UGS/ES (n=10) | | UGS/PS (n=10) | | Total (n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Evaluation | 3.92 | .52 | 3.89 | .32 | 3.96 | .28 | 3.92 | .39 |
| Potency | 3.11 | .16 | 3.21 | .16 | 3.20 | .15 | 3.17 | .16 |
| Activity | 3.76 | .38 | 3.69 | .25 | 3.64 | .20 | 3.70 | .29 |
| Personality | 3.22 | .22 | 3.47 | .20 | 3.42 | .26 | 3.36 | .25 |

APPENDIX 5

TABLE 1

Pre- and Posttest Means and Standard Deviations
for the Participants' Actual Laboratory Time (Minutes)

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (pre n=11) (post n=12) | | UGS/ES (pre n=6) (post n=9) | | UGS/PS (pre n=6) (post n=8) | | Total (pre n=23) (post n=29) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Pretest Time | 64 | 24.5 | 63 | 56.7 | 102 | 53.7 | 74 | 43.9 |
| Posttest Time | 86 | 49.0 | 57 | 52.9 | 94 | 39.3 | 79 | 50.4 |

TABLE 2

Pre- and Posttest Means and Standard Deviations
for the Participants' Attitude Toward Teaching
(Like 5 to 1 Dislike)

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (pre n=12) (post n=12) | | UGS/ES (pre n=7) (post n=10) | | UGS/PS (pre n=8) (post n=10) | | Total (pre n=27) (post n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Pretest Attitude | 4.83 | .39 | 4.57 | .53 | 4.88 | .35 | 4.78 | .43 |
| Posttest Attitude | 4.61 | .48 | 4.29 | .71 | 4.55 | .46 | 4.49 | .49 |

TABLE 3

Pre- and Posttest Means and Standard Deviations
for the Attitude of Participants Toward Their Students
(Like 5 to 1 Dislike)

| | Component/Section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UC (pre n=12) (post n=12) | | UGS/ES (pre n=8) (post n=10) | | UGS/PS (pre n=8) (post n=10) | | Total (pre n=28) (post n=32) | |
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Pretest Attitude | 4.36 | .47 | 4.35 | .61 | 4.41 | .44 | 4.37 | .49 |
| Posttest Attitude | 4.49 | .50 | 4.32 | .71 | 4.39 | .48 | 4.41 | .60 |

APPENDIX 6

TABLE 1

Publication Date of the Textbooks Used by Participants

Component/Section

| | UC (pre n=16) (post n=12) | | UGS/ES (pre n=12) (post n=10) | | UGS/PS (pre n=14) (post n=9) | | AY/B ('72 n=11) | | AY/C ('72 n=4) | | Total ('72 n=57) (post n=31) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. | $\bar{x}$ | S.D. |
| Pre Given in 1972 | 1966.9 | 3.43 | 1966.7 | 1.93 | 1966.8 | 1.36 | 1967.9 | 1.19 | 1968.1 | 1.99 | 1967.4 | 1.98 |
| Post Given in 1973 to Unitary | 1968.3 | 2.00 | 1969.1 | 1.23 | 1968.1 | 1.85 | | | | | 1968.5 | 1.68 |

APPENDIX 7

TABLE 1

Science Classroom Activities Checklist:
Teacher's Perceptions

A

1. The student's role is to copy down and memorize what the teacher tells him.

2. students should frequently be allowed time in class to talk among themselves about ideas in science.

3. Over 25% of the class time should be devoted to students answering orally or in writing answers to questions that are in the textbook or in study guides.

4. Classroom laboratory activities, such as experiments and demonstrations, should usually be performed by students rather than by the teacher.

5. Science classes should provide for some discussion of the problems facing scientists in the discovery of a scientific principle.

6. If a student disagrees with what the teacher says, he should say so.

7. Most questions students ask in class should be to clarify statements made by the teacher or the text.

8. It is important that students discuss the evidence behind a scientist's conclusion.

B

9. A majority of class time should be spent lecturing about science.

10. A teacher should be very hesitant to admit his mistakes.

11. A teacher should generally provide the answer when students disagree during a discussion.

12. It is desirable for teachers to frequently repeat to their students almost exactly what is in the textbook.

13. A teacher should frequently cause students to explain the meanings of statements, diagrams, graphs, etc.

14. Science should be presented as having almost all the the answers to questions about the natural world.

15. Teacher questions should require students to think about ideas they have previously studied.

16. Teacher questions should force students to think about the evidence that is behind the statements that are made in the textbook.

17. The general objectives of a lesson should be understood by the students before work on the lesson is begun.

18. Students should learn most of the details stated in the text.

19. It is important that students frequently write out definitions to work lists.

20. When reading the textbook, students should be expected to look for the main problems (ideas) and for the evidence that supports them.

21. Students should be taught how to ask themselves questions about statements in the text.

22. The textbook and the teacher's notes should provide about the only sources of scientific knowledge for class discussion.

C

23. Students should often be asked to read in sources of information (Books, magazines, etc.) other than their textbook.

24. The student should often be required to keep outline notes on sections of the textbook.

25. The textbook is based on scientific fact and as such should not be questioned by students.

D

26. Tests should include many items based on what students have learned in their laboratory investigations.

27. Tests should often require writing out the definitions of terms.

28. Tests should often ask students to relate ideas that they have learned at different times.

29. Tests should often require the figuring out of answers to new problems.

30. Tests should often provide data the students have not seen previously and ask the students to draw conclusions from these data.

31. Tests should often require students to put labels on drawings.

32. Student evaluation should include formal means of evaluating the performance of skills learned in laboratory activities; e.g. observation, interpretation of data, etc.

33. Tests should seldom contain problems which involve the use of mathematics in their solution.

34. Students should occasionally be given problems for which they must design ways of looking for solutions.

35. Students should occasionally be given research reports and asked to evaluate the procedures used in looking for solutions to the problem.

36. It is a waste of time after a test to have students discuss questions they have on the test.

E

37. Students should be told step-by-step what they are to do in the laboratory.

38. Students should spend time before most laboratory investigations in discussing the purpose of the experiment.

39. Equipment and solutions should not be gathered and/or prepared in advance of laboratory sessions.

40. Science laboratories should meet on a regularly scheduled basis (such as every Friday).

41. The laboratory should often be used to investigate a problem that comes up in class.

42. A laboratory should usually precede the discussion of the specific topic in class.

43. Laboratory activities should usually be related to the topic that is being studied in class.

44. Students should usually know the answer to a laboratory problem that they are investigating before they begin the experiment.

F

45. Most laboratory activities should be done by the teacher or other students while the class watches.

TURN PAGE

46. It should be expected that the data collected by various members of a class will often be different for the same experiment.

47. During an experiment the students should record their data at the time they make their observations.

48. Students should sometimes be asked to design their own experiments to seek answers to a question that puzzles them.

49. Students should often ask the teacher if they are getting correct results in their experiment.

50. The teacher should answer most questions about laboratory work by asking the students questions.

51. One fourth or less of class time should be spent doing laboratory work.

52. Students should always be required to follow teacher or laboratory manual specified ways of doing laboratory work.

53. Laboratories should be directed at students thoroughly learning the names of specific structures and specific sequences of events.

F

54. Laboratory observations should be discussed within a day or two after the completion of the session.

55. After completion of a laboratory activity individual students or student groups should have an opportunity to compare data.

56. Students should be required to copy the purposes, materials, and procedures used in their experiments from the text or laboratory manual.

57. Students should be allowed to go beyond the regular laboratory exercise and do some experimenting of their own.

58. Students should have an opportunity to analyze the conclusions that they have drawn in the laboratory.

59. A class should be able to explain all unexpected data collected in the laboratory.

60. Students should spend time in the interpretation of graphs and tables of the data which they collect.

G

START HERE

## TABLE 2

### Science Classroom Activities Checklist: Student Perceptions

1. My job is to copy down and memorize what the teacher tells us.
2. We students are frequently allowed time in class to talk among ourselves about ideas in science
3. Over 25% of our class time is spent in answering orally or in writing answers to questions that are in the textbook or in study guides.
4. Classroom laboratory activities, such as experiments and demonstrations, are usually done by students rather than by the teacher.
5. We sometimes discuss the problems faced by scientists in the discovery of a scientific principle.
6. If I don's agree with what my teacher says, he wants me to say so.
7. Most of the questions that we ask in class are to clear up what the teacher or text has told us.
8. We often talk about the kind of evidence that is behind a scientist's conclusion.
9. A majority of our class time is spent listening to our teacher tell us about science.
10. My teacher doesn't like to admit his mistakes.
11. If there is a disagreement among students during a discussion, the teacher usually tells us who is right.
12. My teacher often repeats almost exactly what the textbook says.
13. My teacher often asks us to explain the meaning of statements, diagrams, graphs, etc.
14. My teacher shows us that science has almost all of the answers to questions about the natural world.
15. My teacher asks questions that cause us to think about ideas that we have previously studied.
16. My teacher often asks questions that cause us to think about the evidence that is behind statements that are made in the textbook.
17. The teacher tries to be certain that we understand the general objectives (purposes) of a lesson before we begin work on the lesson.
18. When reading the text, we are expected to learn most of the details that are stated there.
19. We frequently are required to write out definitions to word lists.
20. When reading the textbook, we usually are expected to look for the main problems and for the evidence that supports them.
21. Our teacher tries to teach us how to ask ourselves questions about statements in the text.
22. The textbook and the teacher's notes are about the only sources of scientific knowledge that are discussed in class.
23. We often read in sources of science information (books, magazines, etc.) other than our textbook.
24. We are often required to outline sections of the textbook.

25. Our teacher does not like us to question information contained in our textbook

26. Our tests include many questions based on things that we have learned in our laboratory investigations.

27. Our tests often ask us to write out definitions of terms.

28. Our tests often ask us to relate ideas that we have learned at different times.

29. Our tests often ask us to figure out answers to new problems.

30. Our tests often give us data we have not seen previously and ask us to draw conclusions from these data.

31. Our tests often ask us to put labels on drawings.

D

32. We are often tested on our ability to perform skills, such as make observations, the interpretation of data, etc. which we have learned in our laboratory activities.

33. Our tests generally do not contain problems which require the use of mathematics in their solution.

34. Sometimes we are given problems for which we must think up and state ways of looking for solutions.

35. Occasionally we are given information on completed research and asked to evaluate the procedures used by the researcher for looking for solutions to the problem.

36. We seldom have the opportunity to discuss in class the questions that are asked on our tests.

37. My teacher usually tells us step-by-step what we are to do in our laboratory activities.

38. We spend some time before most laboratory investigations discussing the purpose of the experiment.

39. We often cannot finish our experiments because it takes so long to gather equipment and prepare solutions.

E

40. The class works in the laboratory on a regularly scheduled basis (such as every Tuesday and Friday).

41. We often use the laboratory to investigate a problem that comes up in class.

42. The laboratory investigation usually comes before we talk about the specific topic in class.

43. Our laboratory activities are usually related to the topic that we are studying in class.

44. We usually know the answer to a laboratory problem that we are investigating before we begin the experiment.

45. Most of our laboratory activities are done by the teacher or other students while the class watches.

46. The data that I collect for an experiment are often different from data that are collected by the other students for the same experiment.

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TABLE 2 (continued)

47. During an experiment we record our data at the time we make our observations.

48. We are sometimes asked to design our own experiment and to seek answers to a question that puzzles us.

F

49. Our teacher wants us to ask him if we are getting correct results in our experiments.

50. The teacher answers most of our questions about the laboratory work by asking us questions.

51. We spend less than one-fourth of our time in science class doing laboratory work.

52. We never have the chance to try our own ways of doing the laboratory work.

53. Our laboratory often consists of thoroughly learning the names of specific structures and specific sequences of events.

54. We talk about what we have observed in the laboratory within a day or two after every activity.

55. After completion of a laboratory activity, we compare the data that we have collected with the data of other individuals or groups.

56. We are required to copy the purposes, materials, and procedures used in our experiments from the text or laboratory manual.

G

57. We are allowed to go beyond the regular laboratory exercise and do some experimenting on our own.

58. We have a chance to analyze the conclusions that we have drawn in the laboratory.

59. The class is able to explain all unexpected data that are collected in the laboratory.

60. We students spend time in the interpretation of graphs and tables of the data that we collect.

TABLE 3

Vocabulary for the Semantic Differential

SCALES

| | | | | |
|---|---|---|---|---|
| A | 1. | INTERESTING | :::: :::: :::: :::: :::: | BORING |
| | 2. | VALUABLE | :::: :::: :::: :::: :::: | WORTHLESS |
| | 3. | GOOD | :::: :::: :::: :::: :::: | BAD |
| | 4. | PLEASANT | :::: :::: :::: :::: :::: | UNPLEASANT |
| B | 5. | EASY | :::: :::: :::: :::: :::: | DIFFICULT |
| | 6. | LARGE | :::: :::: :::: :::: :::: | SMALL |
| | 7. | STRONG | :::: :::: :::: :::: :::: | WEAK |
| | 8. | HEAVY | :::: :::: :::: :::: :::: | LIGHT |
| C | 9. | FAST | :::: :::: :::: :::: :::: | SLOW |
| | 10. | DOING | :::: :::: :::: :::: :::: | READING |
| | 11. | ACTIVE | :::: :::: :::: :::: :::: | INACTIVE |
| | 12. | BUSY | :::: :::: :::: :::: :::: | DOING NOTHING |
| D | 13. | FRIENDLY | :::: :::: :::: :::: :::: | ALOOF |
| | 14. | LIVELY | :::: :::: :::: :::: :::: | TIRED |
| | 15. | EASY-GOING | :::: :::: :::: :::: :::: | BOSSY |
| | 16. | NICE | :::: :::: :::: :::: :::: | MEAN |

Subscale A = Evaluation

Subscale B = Potency

Subscale C = Activity

Subscale D = Personality