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COOPERATIVE COLLEGE-SCHOOL SCIENCE PROJECT--FIRST, SECOND, AND THIRD YEAR REPORTS.

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DISTRICT OF COLUMBIA COUNC. OF ENG. AND ARCHITECT.

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DESCRIPTORS- *CURRICULUM DEVELOPMENT, *EDUCATIONAL PROGRAMS, *ELEMENTARY SCHOOL SCIENCE, *SECONDARY SCHOOL SCIENCE, *TEACHER EDUCATION, BIOLOGY, INSERVICE TEACHER EDUCATION, PROGRAM DESCRIPTIONS, SCIENCE TEACHERS, NATIONAL SCIENCE FOUNDATION, COOPERATIVE COLLEGE SCHOOL SCIENCE PROGRAM, BIOLOGICAL SCIENCES CURRICULUM STUDY, ELEMENTARY SCIENCE STUDY, SCIENCE A PROCESS APPROACH

PROGRAMS DESIGNED TO IMPROVE ELEMENTARY AND SECONDARY SCHOOL SCIENCE INSTRUCTION THROUGH THE IMPLEMENTATION OF NEW SCIENCE COURSES ARE DESCRIBED IN THREE ANNUAL REPORTS. TEACHERS ATTENDED INTENSIVE SUMMER PROGRAMS THAT WERE PLANNED AND CONDUCTED BY COLLEGE AND UNIVERSITY PROFESSORS AND BY TEACHERS WHO HAD PREVIOUS EXPERIENCE TEACHING THE NEW COURSES. PROGRAM FEATURES INCLUDED (1) LECTURES BY OUTSTANDING SCIENTISTS ON CURRENT RESEARCH ACTIVITIES, (2) DISCUSSION SESSIONS, AND (3) LABORATORY ACTIVITIES. MEETINGS CONDUCTED DURING THE NEXT ACADEMIC YEAR DEALT WITH PROBLEMS ENCOUNTERED IN THE IMPLEMENTATION AND TEACHING OF THE NEW PROGRAMS. THE PARTICIPANTS' SUBJECTIVE EVALUATION OF THE PROGRAMS AND THE NATURE OF THEIR SUBSEQUENT TEACHING ACTIVITIES WERE DETERMINED THROUGH FOLLOW-UP STUDIES. SCHOOL ADMINISTRATORS' OPINIONS CONCERNING THE IMPLEMENTATION OF NEW SCIENCE COURSES AND THE EFFECT OF THE COOPERATIVE PROGRAM ON TEACHERS WERE OBTAINED THROUGH THE USE OF QUESTIONNAIRES. (AG)

REPORT ON THE FIRST YEAR OF

A COOPERATIVE COLLEGE-SCHOOL SCIENCE PROGRAM

SUPPORTED BY

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TO THE JOINT BOARD ON SCIENCE EDUCATION

OF THE WASHINGTON ACADEMY OF SCIENCES

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August 2, 1965

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General Description

The Cooperative College-School Science Program is designed to assist local school systems[1] in the improvement of science instruction and materials. With many new curricula becoming available, school systems are faced with the problem of introduction to teachers in a situation where staff turnover is very high. Simply to train new teachers is a sizable task but orientation to very new and different materials at all levels is overwhelming. "I think everyone agrees that much more extensive teacher education programs are going to be necessary."[2]

In the first year of the CCSS Program, high school biology teachers utilized biology materials developed by the Biological Science Curriculum Study. Through the efforts of outstanding scientists and educators over a number of years of development and testing, BSCS has made available a wealth of materials in which biological knowledge is organized along broad conceptual lines such as the "Genetic Continuity of Life" and laboratory exercises which stress inquiry as the fundamental process of science. Facts develop from the involvement of the student in the "process of discovery." This contrasts with traditional material in which

> the laboratory is too often a self demonstration exercise--a kind of busy work in problem doing.[3]

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1. In the first year, teachers from six school systems and three private schools participated. See Appendix A and B.

2. From a personal letter from Dr. Richard W. Van Norman, Assistant Program Director, Course Content Improvement Section, NSF.

3. From a summary of a colloquia on Biological and Social Science led by Paul F. Brandwein, Conservation Foundation. January 28, 1964. Washington, D.C.

Twenty-six high school biology teachers attended a month-long program held at Montgomery Junior College[4] in the summer of 1964 stressing laboratory techniques in BSCS Biology and supplemented by fifteen lecturers from private companies, governmental agencies, and universities, who described current biological research. Dr. Ellis T. Bolton from the Carnegie Institution of Washington, described his recently published research on the genetic relatedness of organism. Dr. William O. Negherbon, a Harvard Ph.D. and member of Phi Beta Kappa, combined a lecture and laboratory on symbiosis and parasitism for an outstanding and unique experience. Two college biologists and a high school biology teacher experienced in the presentation of BSCS conducted the laboratory and seminars.

Following the summer program six informal meetings held on Saturday mornings at different schools afforded teachers the opportunity to observe varying teaching situations. Here, the group shared problems and methods in presenting BSCS Biology. These sessions included talks, films, and demonstrations designed to assist the teachers in their classrooms. We were especially fortunate to have Dr. Charles A. Hufnagel illustrate with colored films his development of artificial heart valves and their first successful use in human beings.

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4. Montgomery Junior College is a public institution of higher learning, a part of and supported by Montgomery County Board of Education and the State of Maryland. The college is active in a variety of developments in education including teaching machines, programmed courses, and a program of early placement for superior high school students in Montgomery County. A second campus will be opened in the fall semester of 1965. The college is well-suited to offer a broad range of activities in the sciences. The five year old science building was built at a cost of over one-half million dollars, and has been completely equipped with modern instruments, including a complete radioisotope laboratory financed by grants from the Atomic Energy Commission and the Public Health Service.

Operation

The initial planning for the program began in the fall of 1962. A preliminary survey made at that time in four Maryland counties identified both the need and demand for a training program to assist teachers in introducing the recently available biology materials developed by the Biological Sciences Curriculum Study. With a grant from the National Science Foundation to the Joint Board on Science Education necessary financial support allowed the program to proceed. The advice and encouragement of Dr. John K. Taylor, Director of Science Projects of the Joint Board, has been especially valuable in the success of the program.

The director established extensive contacts with participating school systems; science supervisors advised on the selection of participants; high school principals received notification of acceptance of their teachers. Upon the teacher's satisfactory completion of the program, principals received a certificate that summarized the program's activities. We utilized this opportunity to state some of the objectives and needs of the BSCS oriented programs.[5]

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5. An excerpt from a letter of acceptance notification sent to principals: "We understand that the above named teacher(s) will use BSCS text and laboratory materials in their classes beginning in September. Increased laboratory experiences which aid students in appreciation of science as a process of inquiry is one of the objectives of BSCS Biology program. A successful laboratory will require not only considerable equipment, but also a sufficient supply of funds and student help in the laboratory."

Description of the Summer Program

Between June 22 and July 17, 1964, the group met five days a week from 8:30 a.m. to 3:30 p.m., spending about 75% of the time in the laboratory with the remainder in lectures and seminars. The summer program extended over 120 hours, thus exceeding the classtime in a four credit hour college course. Lectures were, on the average, one hour in length with an additional thirty minutes for discussion. The fifteen participating scientists, selected because of research activities related to the laboratory sessions and their own interest in communicating with high school teachers, represented a cross-section of activities in the Washington metropolitan area. We provided each speaker with a copy of the BSCS experimental edition so, whenever possible, they referred to text and laboratory materials.

Summary of Lectures

Energy Exchange in the Biosphere by Dr. Dale Jenkins, Chief, Environmental Biology, Office of Space Science, NASA, Beltsville, Maryland. Current space efforts were described and the information obtained about life and energy exchange in the outer atmosphere summarized.

Population Dynamics by Mr. Robert Cook, President, Population Reference Bureau, Washington, D.C. A history of human population growth and factors involved in its present characteristics were presented. Greater social and economic problems resulting from the rate of increase are projected for the future.

Symbiosis and Parasitism by Dr. William O. Negherbon, Hazleton Laboratories, Falls Church, Virginia. Species of Plasmodium and flagelate protozoa were used as primary examples of the fine line existing between the two types of association.

Current Research in Virology by Dr. Paul Vasington of Flow Laboratories, Rockville, Maryland. Current research on viruses and respiratory disease through tissue culture methods were described.

Investigations of Microbial Associations by Dr. Michael Pelczar, Professor of Microbiology, University of Maryland. The history of bacteriology was summarized and specific research into interaction of competing microbial populations presented.

Diversity of Microbes by Dr. Harold E. Finley, Professor of Zoology, Howard University, Washington, D.C. Classification of microbes was analyzed and specific techniques involved in using protozoa in the classroom presented.

Evidence of Early Life in Fossil Rock by Dr. Thomas C. Hoering of the Carnegie Institution of Washington, Washington, D.C. Recent techniques in the analysis of amino acids in fossil rocks by gas chromatography reveals new knowledge on ancient life and geological history.

Methods of Research on Cell Organelles by Roland M. Nardone, Professor of Biology, Catholic University, Washington, D.C. Current research on mitochondria and lysosomes. Techniques in fractionation, separation and tracing of metabolic pathways was described.

Photosynthesis by Mr. Jehu Hunter, Laboratory of Biochemistry, National Institutes of Health, Bethesda, Maryland. Evolution of knowledge about photosynthesis provides an historical perspective on current controversies in the field.

Mechanisms of Transport Across Biological Membranes by Dr. Charles S. Tidball, Professor of Physiology, The George Washington University School of Medicine, Washington, D.C. Survey of function and structure of biological membranes, analysis of specific mechanisms involved in active transport were presented.

Nucleic Acid Interaction: A Molecular Approach to the Study of Genes and Their Products by Dr. Ellis T. Bolton of the Carnegie Institution of Washington, Washington, D.C. A method of matching up fundamental genetic units of different species provides a quantitative measure of their degree of relatedness. Radioisotope techniques are used.

The Analysis of Behavior or the Ecology of Behavior by Dr. Israel Goldiamond, Director of the Institute for Behavioral Research, Silver Spring, Maryland. Behavior may be described by the analysis of hypothetical mechanisms or by a description of the overt observable actions in specific invironmental conditions.

Space Biology by Dr. Richard Belleville, Chief, Behavioral Biology, NASA, Beltsville, Maryland. Current research on man and animals in space was described.

Anthropology and Evolution by Dr. J. Lawrence Angel, Curator of Physical Anthropology, Smithsonian Institution, Washington, D.C. The study of ancient skeletons may not only give an accurate description of the individual but also of the general health and habits of the population.

Effects of Changing Environment on Wildlife by Dr. John Aldrich, Division of Wildlife Research, Department of Interior, Washington, D.C. Man's alteration of the environment has dramatically affected wildlife--usually in detrimental ways.

Summary of Laboratories and Seminars

Laboratory exercises were selected to demonstrate difficult or unique techniques found in Biological Sciences Curriculum Study materials with the sequence of activities organized primarily around the BSCS Green Version. Three laboratory blocks (Plant Growth and Development by A. E. Lee, Animal Growth and Development by F. Moog, and Microbes: Their Growth, Nutrition, and Interaction by A. S. Sussman) supplied additional exercises. These blocks are intended for use over a six-week period in the high school biology class to give an intensive experience around a selected theme. The highly organized program schedule suggests, on an intensified scale, the planning necessary for a successful BSCS class. An experienced high school BSCS teacher conducted select laboratories in the same manner as in a high school. The following summary of activities identifies only the beginning of topics, many of which extend over two or three weeks.

First Week, June 22-26, 1965

From the Green Version: Observation and classification of living things, parameters affecting the germination of seeds, interrelationships of producers and consumers, study of population growth through yeast cultures--dilution and counting techniques, effect of an abiotic environmental factor on a population the budding rate of hydra in relation to temperature, use of dichotomous keys (participants received a copy of A Guide to the Study of Fresh-Water Biology by J. G. Needham, 5th ed. Holden-Day Press, $2.50), transfer and culturing of bacteria and their identification.

From the Plant Block: test for seed viability, effect of light on the germination of lettuce seed, patterns of growth in plants, internal changes in structure and organization of plants in relation to growth, a quantitative measurement of respiration in germinating seeds, photosynthesis and mineral nutrition.

Seminars: Discussion of culture techniques and research on Hydra by Dr. Helen Park of the National Institutes of Health, bacteriological techniques by Mrs. Evelyn Hurlburt, preparation of living materials to demonstrate symbiosis and parasitism--protozoa from the hindgut of the wood roach Cryptocercus punctulatu Plasmodium from the blood of an infected white rat, various parasites found in the frog, examination of tissue culture tubes--normal growth and the effects of viruses.

Second Week, June 29 - July 3, 1964

Green Version: capillary circulation, microscopic study of bacteria--staining and identification, identification of substances in protoplasm--tests for proteins, fats, and sugars. Drosophila techniques and a monohybrid cross.

Microbe Block: preparation of bacterial and fungal enrichment cultures, identification of fungi imperfecti.

Animal Block: removal of frog pituitary, artificial parthenogenesis and fertilization of frog eggs, temperature and heart beat of a three day old chick embryo.

Seminar: demonstration of Chi square test and Fisher's Analysis of Variance, techniques in the silver staining of protozoan organelles.

Third Week, July 6-10, 1964

Green Version: separation of plant pigments by chromatography, and a comparison of techniques diffusion of substances through a membrane, mitosis and squash and smear technique, genetic differences in peas.

Animal Block: influence of a thyroid inhibitor of the development of the chick embryo, influence of sex hormones on the development of the chick, statistical analysis of experimental data.

Microbe Block: analysis of nutritional requirement of Neurospora crassa.

Radioisotope Laboratory: radioisotope tracer uptake in plants, survey with the GM counter, quantitative assay, preparation of autoradiographs.

Fourth Week, July 13-17, 1964

Green Version: Social behavior of fish, the reproductive behavior of Betta splendens, germination of pollen grains.

Microbe Block: isolation of antisocial microbes, effect of temperature on fungal growth, microbial antagonisms.

Seminar: Discussion of the f A World to Perceive by Dr. Richard D. Walk, Department of Psychology, George Washington University. Discussion of the film Learning About Learning by Dr. Israel Goldiamond.

Results

On the basis of two separate evaluations by teachers,[6] the first Co-operative College-School Science Program was exceptionally helpful. Teachers felt that the entire staff was interested in their problems and that a sufficient part of the program concerned practical problems. At least twenty teachers achieved a high percentage of implementation of BSCS materials and methods.[7] Even in cases where teachers are still using traditional texts, it is common to find the use of BSCS laboratory guides. Almost one-half said they would not have attempted the new materials without the help of the program.

Virginia teachers receive four hours credit toward certificate renewal for successful completion of the program.[8] The State of Maryland recognizes the program as four hours of workshop credit toward the Advanced Professional Certificate.[9]

A considerable number of contacts developed between high school teachers and biological scientists in the area. Subsequent informal visits between these parties have supplemented the effective Visiting Scientist Program operated by the Joint Board on Science Education.

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6. Refer to Appendix C and D

7. Refer to Appendix E

8. Based on a letter from Miss Francis H. Gee, Assistant Supervisor of Teacher Education, Virginia State Board of Education.

9. Based on a letter from Mr. John C. Metzger, Assistant Supervisor of Certification, Maryland State Department of Education.

The Cooperative College-School Program offers a partial answer to the problems of curriculum implementation and teacher training. A community college is closer to the problems of local school systems and may provide a flexible situation to meet varying needs. We have successfully combined a series of lecturers in specialized research areas with a laboratory program emphasizing practical techniques to produce a program of particular meaning for experienced teachers.[10]

Hindrances to effective teaching fall into four categories: teaching loads, short periods, finances, and administration. Laboratory-oriented programs such as BSCS require a tremendous investment of time for preparation. Lack of adequate time or help in preparation for laboratory exercises is probably the most important hindrance to a quality program. Classes are large, averaging over thirty students, making for a shortage of equipment and working space. Fortunately, most teachers in the program taught only biology classes thereby avoiding the added burden of diverse preparations associated with junior high schools or high schools in smaller systems. In only one case did the length of class periods fall under 55 minutes--considered the minimum for effective laboratories. A period of at least 55 minutes is required in the State of Maryland. However, the lack of any double period imposes a hardship on teachers and students. In the few cases where overcrowding has not prevented scheduling of at least one double period a week, laboratory programs have more flexibility. Given time, a teacher can work around many financial handicaps but in most cases there is neither ample time nor funds.

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10. Refer to the Article "Science Curriculum Implementation" by Robert B. Nicodemus in the October 1965 issue of Science Education.

The average expenditure per pupil for supplies and equipment in thirteen public schools was $2.95. BSCS recommends an expenditure of $500 per teacher for supplies alone.[11] This is equivalent to at least $3.33 per student (on the basis of 150 student load average). Only two of the fourteen reporting public schools met or exceeded this amount.[12] The range of expenditures is wide, varying by a factor of ten. In Montgomery County one high school had the second lowest expenditure ($0.87 per student) and another, the highest ($8.00). With such variable budgets the statement that, "Departments with effective chairmen usually do better than others--Human nature."[13] is all too true.

> Much money and much effort have gone into the improvement of science teaching in the elementary and secondary grades. One area that now needs special attention is the provision of larger budgets for supplies and equipment, for there is a great gap between the amounts that are available in most schools and the amounts that should be available.[14]

It is difficult to obtain specific information on complaints about administration. Two teachers complained of having to spend all funds by March 1. Two other teachers complained of almost no equipment or supplies. This information differed from what the principal had said, thus pointing out one of few cases of failure of communication between administration and teachers.

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11. Biology Teachers' Handbook. J. J. Schwab, Ed., J. Wiley & Sons. 1963. p. 536.

12. Washington-Lee is not included since their figure includes capital expenditures.

13. From a personal letter from Mr. Edmund T. Burke, Supervisor of Science.

14. From an editorial by Dale Wolfe in Science. Vol 147 No. 3660, February 19, 1965. p. 827.

The Administrative Viewpoint

The most consistant impression the director obtained from interviews with six principals was a sympathetic awareness towards problems in science education. For convenience, this portion of the study was limited to Montgomery County. The results suggest additional areas that should be studied. All of the principals interviewed stated that teaching loads are too heavy. Four of the six believed that five class a day are reasonable with smaller class sizes. The idea of a full-time paid laboratory assistant is received favorably, especially since it would enable a more productive use of teacher time. Only one expressed concern over effective use of additional time due to the lack of professionalism or dedication.

Although principals believe that double periods are desirable, only one of the six found it possible to schedule one on a regular basis. On this point they evidenced greatest difference. See Appendix G.

Finances are a problem. Insufficient funds and the absence of guidelines regarding the financial requirements of a laboratory program detract from a quality program.[15] Although all principals stated that departments should be consulted regarding finances, not all teachers are aware of this.

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15. Interested administrators should refer to:

    BSCS Biology--Implementation in the Schools. BSCS Bulletin No. 3. Available in paperback from BSCS, University of Colorado, Boulder, Colorado.

    The New School Science. A Report to School Administrators on Regional Orientation Conferences in Science. American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington, D.C.

Recommendations for the Improvement of Science Instruction*

1. A full-time paid laboratory assistant should be provided for every four teachers of a laboratory science.
2. The number of students per class should be limited to 25.
3. The number of classes a teacher is assigned should not exceed five for one preparation or four for two different preparations.
4. A minimum of $3.00 per student for supplies alone should be allotted for biology. Additional funds as necessary should be available for equipment.
5. Purchasing procedures should allow teachers to order live materials throughout the entire school year.
6. Administrators should be supplied with realistic up-to-date guidelines for the effective administration of science programs.
7. School systems should establish a permanent Cooperative College-School Science Program to help implement the adoption of improved course materials and to develop a variety of programs of benefit to the co-operating school systems.
8. Contracts for the operation of CCSS Programs should be established early enough so that effective planning may be made. Where a summer program is involved, funds should be committed by the preceding month of February.

* Based on contacts by the director with the teachers and administrators actively concerned with existing problems.

Summary

The pilot program supported by the National Science Foundation contributes substantially to the science programs of Metropolitan area schools. It is apparent that it would be valuable to continue to provide this type of cooperative service in the future.

> It is only the long-run improvement that means much. In regard to the teachers, it is of prime importance to communicate with them and to be concerned with helping them strengthen themselves.[16]

Specific accomplishments are:

1. Identification and establishment of a successful working relationship between a public junior college and surrounding school systems.
2. Successful combination of a lecture series by outstanding area scientists on areas of their own research interest with a laboratory program of practical use to experienced teachers.
3. An opportunity for teachers to obtain and exchange help on their science programs through a series of academic year meetings.
4. Recognition of the summer program as the equivalent of four hours of graduate credit which may be used for certification purposes by teachers from Maryland and Virginia.
5. Suggestion of a means for evaluation of teaching situations and accomplishments of a school or school system in science education.
6. Recommendations for the improvement of science programs in high schools and suggestions for further cooperative efforts such as coordinating a program of research opportunities for students in local laboratories.

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16. From a summary of an address by Dr. John H. Fisher, President of Teachers College, Columbia University, on "Problems in the Training and Retraining of Teachers," January 27, 1964, Sheraton Park Hotel, Washington, D.C.

Appendix A

List of teacher-participants in the 1964 Summer Program

Mr. Willits D. Ansel
Sidwell Friends School
Washington, D.C.

Mr. Wanamaker Barnes
Fairmont Heights High School
Washington 27, D.C.

Mr. Edward E. Burgee
Walter Johnson High School
Bethesda, Maryland

Mr. Joseph P. Campitell
Robert Peary High School
Rockville, Maryland

Mr. Vaughn L. Carmichael
High Point High School
Beltsville, Maryland

Sister Mary Cecilia Clark
Georgetown Visitation Prep.
Washington, D.C.

Miss Hilda Y. Dryer
Washington-Lee High School
Arlington, Virginia

Mr. Herman L. Firebaugh
McLean High School
McLean, Virginia

Mrs. Camilla M. Griffiths
Bethesda-Chevy Chase High School
Bethesda 14, Maryland

Mrs. Dorothy L. Hanzal
George Marshall High School
Falls Church, Virginia

Mr. Kerry L. Highsmith
Richard Montgomery High School
Rockville, Maryland

Mr. Paul J. Hummer
Lingamore Jr-Sr High School
Frederick, Maryland

Mrs. Lorraine J. Johnson
Spingarn High School
Washington, D.C.

Mr. Stanley R. Kilkuskie
Richard Montgomery High School
Rockville, Maryland

Mr. James T. Morris
Northwood High School
Silver Spring, Maryland

Miss Sara T. Murphy
Walt Whitman High School
Bethesda, Maryland

Mr. Charles Nichols, Jr.
Walt Whitman High School
Bethesda, Maryland

Mr. Nathan P. Pearson
Albert Einstein High School
Kensington, Maryland

Mr. Jack D. Ramsey
Albert Einstein High School
Kensington, Maryland

Mr. James F. Reed
Frederick High School
Frederick, Maryland

Mrs. Pearl H. Richardson
Robert Peary High School
Rockville, Maryland

Sister Rosamystica MacDermott
La Reine High School
Washington, D.C.

Miss Goldie Smith
Douglass Jr-Sr High School
Upper Marlboro, Maryland

Mr. Harold G. Swain
Mt. Vernon High School
Alexandria, Virginia

Mr. John P. Wetherill
Walter Johnson High School
Bethesda, Maryland

Mrs. Constance Wrench
Walt Whitman High School
Bethesda, Maryland

Montgomery County Public Schools, Maryland	Rockville, Maryland
Dr. Homer O. Elseroad Superintendent of Schools	Mr. Edmund T. Burke Science Supervisor
Albert Einstein High School Newport Mill Road Kensington, Maryland	Mr. Thomas A. Conlon, Jr. Principal
Bethesda-Chevy Chase High School 4301 East West Highway Bethesda, Maryland	Mr. James B. Williams Principal
Northwood High School University Boulevard West Silver Spring, Maryland	Mr. Harold R. Packard Principal
Robert E. Peary High School Arctic Avenue Rockville, Maryland	Dr. Frederick L. Dunn, Jr. Principal
Richard Montgomery High School East Montgomery Avenue Rockville, Maryland	Mr. William W. Miles Principal
Walt Whitman High School Whittier Boulevard Bethesda, Maryland	Dr. Daryl W. Shaw Principal
Walter Johnson High School 10311 Old Georgetown Road Rockville, Maryland	Mr. Earl P. Schubert Principal
Prince George's County Public Schools,	Upper Marlboro, Maryland
Mr. William S. Schmidt Superintendent of Schools	Dr. Howard B. Owens Science Supervisor
Douglas Jr. Sr. High School Croom Road Upper Marlboro, Maryland	Mr. Robert Frisby Principal
Fairmont Heights Jr. Sr. High School Nye at Reed Chapel Oaks, Maryland	Mr. G. James Gholson Principal
High Point Sr. High School Powder Mill Road Beltsville, Maryland	Mr. Allan I. Chotiner Principal

Frederick County Public Schools, 115 East Church Street Frederick, Maryland

Dr. John L. Carnochan, Jr.
Superintendent of Schools

Mr. Glen E. Warneking
Supervisor of Science and Math

Frederick High School
Frederick, Maryland

Mr. Warren C. Smith
Principal

Lingamore Jr. Sr. High School
Route 1
Frederick, Maryland 21701

Mr. Harry O. Smith
Principal

District of Columbia Public Schools, 13th and K Streets, N. W. Washington, D.C.

Dr. Carl F. Hansen
Superintendent of Schools

Mr. Keith Johnson
Science Supervisor

Spingarn High School
24th and Benning Rd. N.E.
Washington, D.C.

Dr. Purvis J. Williams
Principal

Arlington County Public Schools, 1426 North Quincy Street Arlington 10, Virginia

Mr. Ray E. Reid
Superintendent of Schools

Dr. Phoebe Knipling
Science Supervisor

Washington Lee High School
1300 North Quincy Street
Arlington, Virginia

Mr. O. U. Johansen
Principal

Fairfax County Public Schools, Fairfax, Virginia

Mr.Earl C. Funderburk
Superintendent of Schools

Dr. Charles Davis
Science Supervisor

George C. Marshall High School
2323 Leesburg Park
Falls Church, Virginia

Mr. Elam K. Herzler
Principal

McLean High School
McLean, Virginia

Mr. Eugene E. Griffith
Principal

Mt Vernon High School
3900 Richmond Highway
Alexandria, Virginia

Mr. Melvin B. Landes
Principal

Private Schools

La Reine High School
4900 Silver Hill Road
Washington, D.C. 20023

Sister Mary Gerald
C.S.B.

Georgetown Visitation Preparatory
1500 - 35th Street N.W.
Washington, D.C.

Sister M. R. Huffman
O.V.J.M.

Sidwell Friends School
3825 Wisconsin Avenue, N.W.
Washington, D.C.

Mr. John H. Colbaugh

Montgomery Junior College
Takoma Park, Maryland 20012

Appendix C Teacher Evaluation of 1964 Summer Program.

"I will feel more secure now as I incorporate the best of BSCS in my teaching."

"This summer program has been more meaningful than any of the other three programs I have attended."

"Both methods and subject matter of the summer program have opened to me new avenues of usefulness."

"The program has been extremely valuable in terms of the practicability of the experiences presented."

"The usefulness of the program in methods and subject matter, in my judgment, will contribute greatly to our school program."

"From inquiries which I have made, I have learned that this program is far more valuable and meaningful than most programs offered to biology teachers through NSF grants."

"I was very much impressed with the total organization of the program, and appreciate the time, work, and effort which went into the planning."

"I have gained a better insight into the BSCS philosophy, and this alone will help to make me a better teacher."

"I have attended previous summer Institutes for secondary science teachers under NSF support, and feel that this program had exceptionally good lecturers."

"I feel that an outstanding job was done in selecting personnel and lecturers for offering this program, especially in the matters of competency and continuity."

"The excellent lecturers have served as a great inspiration. Their value in giving me an overview of the most recent work in various areas cannot be overestimated."

"The lectures by eminent men on the various subject areas were far more informative and interesting than any assignments that might have been given in textbooks."

"Particularly impressive was the evidence that logistic problems of living specimens even when used in large quantities could be solved."

"It has provided valuable experience for myself in performing the exercises, to see just what to expect when working with my classes this coming year."

"The fact that emphasis was placed on laboratory technique and experiments proved very beneficial to me."

"I felt pushed at times...But I would rather have done it as we did than to have it presented in six weeks in one or two places I know about."

"Possibly fewer experiments, or more time allotted to the institute, might enable more experiments to be completed, with less confusion."

"I felt that we covered a tremendous amount of material in a very short time."

"This program has been of greatest value in acquainting me with the BSCS philosophy and updating my knowledge in the biological sciences."

Montgomery Junior College
Takoma Park, Maryland 20012

Appendix D Teacher Evaluations Of The Total First Year Program.

Responses to questions on the final survey made in the Spring semester of 1965.

1. Please estimate how much of your course has been affected by the BSCS biology program you attended at MJC last summer.

2. With the perspective of this past academic year, how would you rate the helpfulness of the summer program.

Mr. Pearson:	1.	"A high percentage of implementation."
	2.	"Extremely helpful."
Mr. Ramsay:	1.	"About 90 percent."
	2.	"Excellent."
Mr. Morris:	1.	"Greatly--100 percent."
	2.	"Excellent."
Mrs. Richardson:	1.	"Labs have undergone change."
	2.	"Extremely helpful."
Mrs. Wrench:	1.	"60 percent."
	2.	"Excellent."
Miss Murphy:	1.	"50 percent"
	2.	"Very helpful."
Mr. Nichols:	1.	"I have used the ideas and some lab exercises."
	2.	"Very helpful."
Mr. Wetherell:	1.	"½ to ½ (lab portion)"
	2.	"The most helpful institute I have attended."
Mr. Burgee:	1.	"50 percent."
	2.	"Very good."
Miss Smith:	1.	"The majority of my laboratory work."
	2.	"Very helpful."
Mr. Hummer:	1.	"It would be hard to answer question one by a percen I had been stealing the BSCS lab sessions for two years prior to teaching it. I would heartily recommend anyone planning to teach BSCS to attend a summer workshop. The work shop certainly helped me very much, and I think the quality of instruction was very good."

Mr. Reed:	1.	"90 percent."
	2.	"Excellent."
Mrs. Johnson:	1.	"I introduced BSCS to one class--modified teaching in other classes."
	2.	"Excellent."
Sister Cecilia:	1.	"About 85 percent."
	2.	"The summer program was excellent. Without this experience I would not have taught BSCS biology this year. It has proved to be successful in every way."
Sister Rosamystica:	1.	"Complete change over from old approach to BSCS."
	2.	"A+."
Mrs. Pryer:	1.	"1/3 of the classes."
	2.	"Without it I would have little insight into BSCS."
Mrs. Hanzal:	1.	"90 percent."
	2.	"Greatly, I would not have attempted to teach without it."
Mr. Firebough:	1.	"Quite a lot--am doing many of the same experiments."
	2.	"Very helpful--we had good instructors. We all feel that your set-up was most helpful and better than at most colleges."

Appendix E 1

Survey of 1964 Teacher-Participants*

Montgomery Co.	Text	BSCS lab blocks	Number of student assistants	Number of classes	Total number of students	Double periods per week	Dept. consulted regarding needs	Total expenditures per student 1964-65
Albert Einstein								$4.00
Mr. Pearson*	BSCS-Y	2	3	5	157	0	yes	
Mr. Ramsay	BSCS-Y	2	3	5	152	0	yes	
Northwood								$1.50
Mr. Morris	BSCS-Y	0	4	5	126	0	yes	
Richard Montgomery								$1.38
Mr. Kilkuskie	BSCS-Y	0	0	5	135	0	?	
Mr. Highsmith	(a)	-	-	-	-	-	-	
Robert E. Peary								$8.00
Mrs. Richardson*	Trad. BSCS-G	0	0	4	101	2	yes	
Mr. Campiteil	BSCS-Y	½	0	5	135	2	yes	
Walt Whitman								$0.87
Mrs. Wrench	Trad.	0	5	5	152	0	no	
Miss Murphy	Trad.	0	few	5	173	0	no	
Mr. Nichols	Trad.	0	2	5	175	0	no	
Walter Johnson								$1.70
Mr. Wetherill	BSCS-Y	0	2	5	150	0	no	
Mr. Burgee	BSCS-B Trad.	0	2	5	160	0	no	

Note: Item 1 BSCS Green Version, High School Biology
BSCS Yellow Version, Biological Science
BSCS Blue Version
Trad., Mainly Modern Biology

(a) "I am not teaching BSCS this year. There was no money available for materials or supplies."

* For the 1964-65 school year

Appendix E 2

Prince Georges Co.	Text.	Block.	Asst.	Classes	Students	Double period	Dept.	Exp. 1964-65
Fairmont								
Mr. Barnes	No Response							
Douglas								
Miss Smith	Trad.	0	0	5	158	0	?	$ 2.00
High Point								
Mr. Carmichael	BSCS-Y	0	0	-	-	0	NO	$ 2.00
Frederick Co.								
Lingamore								
Mr. Hummer	BSCS-G	3	8	6	140	0	YES	$ 6.50
Frederick High								
Mr. Reed	BSCS-G	0	0	5	177	0	YES	$ 3.73
D.C. Public								
Springarn								
Mrs. Johnson	Trad. BSCS-G	0	0	5	147	0	NO	$ 3.00 Supplies only
Private								
Georgetown								
Sister Cecilia	BSCS-G	0	YES	3	68	2	YES	$15.96
La Reine								
Sister Rosamystica	BSCS-G	3	YES	6	212	0	YES	$ 9.90
Sidwell Friends								
Mr. Ansel	No Response							

Appendix E 3

	Text;	Block	Asst.	Classes	Students	Double period	Dept.	Exp. 1964-65
Alexandria, Va.								
Mt. Vernon								
Mr. Swain		No Response						
Arlington, Va.								
Washington-Lee								
Mrs. Dryer	Trad.	0	3	5	133	0	YES	$45.00
Fairfax, Va.								
George C. Marshall								
Mrs. Hanzal	BSCS-G	0	2	5	130	0	NO	$ 3.00
McLean								
Mr. Firebaugh	BSCS-G	3	4	5	141	0	YES	$ 0.66

Appendix F

Detailed Analysis of Biology Expenditures of 1964 participant schools*

1. Total number of students (a) 1964-65 (b) 1963-64
2. Total expenditures for supplies
3. Total expenditures for equipment
4. Total amount spent per student

Montgomery County	1a	2a	3a	4a	1b	2b	3b	4b
Albert Einstein	470	970	630	$ 4.00	350	719	500	$ 3.50
Northwood	650	900	100	$ 1.50	-	-	-	-
Richard Montgomery(b)	560	780	0	$ 1.38	535	850	11000	$22.15
Robert E. Peary	370	1000	1500	$ 8.00	300	1000	1000	$ 8.00
Walt Whitman	560	485	-	$ 0.67	-	-	-	-
Walter Johnson	700	1200	?	$ 1.70	-	-	-	-
Prince Georges Co.								
Douglass	180	160	200	$ 2.00	184	168	200	$ 2.00
Frederick County								
Lingamore(c)	146	750	200	$ 6.50	147	250	100	$ 2.33
Frederick	700	413	2200	$ 3.73	700	586	(e)	$ 0.84
D.C. Public								
Private								
Georgetown	68	543	542	$15.96	38	591	(e)	$15.56
La Reine	212	1000	1000	$ 9.90	220	500	-	$ 2.27
Arlington								
Washington-Lee	746	1750	1660	$45.00	747	3570	(e)	$ 4.76
Fairfax								
McLean	140	200	(d)	$ 0.66	-	-	-	-

(a) Figures do not include several Title III projects which, if included, would make the total figures somewhat higher. The school opened in 1962, therefore, the allotment was higher.
(b) Four new laboratories were opened in 1963.
(c) Most of the BSCS equipment was obtained in 1961.
(d) No expenditures as the laboratory was well equipped when opened in 1963.
(e) Supplies and equipment expenditures not differentiated.
* Based on returned responses of teacher-participants.
\- Breakdown not available.

Appendix G-1

February 25, 1965

Summary of interview with Mr. Thomas A. Conlon, Jr., principal of Albert Einstein Senior High School.

1. To what extent should unscheduled activities or changes in schedules be allowed to interfere with the acdemic program?

   Problems mainly result from insufficient notice being given. There should be a minimum of several days advance notice prior to changes. As far as possible we try to hold to the schedule that is published Friday of the preceeding week. There are no set guidelines - just experience and common sense. Of course it is implied that teachers as well must plan ahead.

2. How desirable is the scheduling of double periods for laboratory courses?

   This is a age old problem. Scheduling just for science courses results in study halls which are not only hard on teachers but are not productive use of student time - of which we have little enough. By having rotating doubles periods it introduces problems for other subjects. For example, it is very difficult for some teachers to hold an NCP class for two hours.

3. Should science departments be consulted for their financial needs in the coming year? How desirable is a budget or formula for departments?

   Department chairmen should by all means be consulted. Formulas or guidelines exist for the opening of new schools but budgeting X dollars per department creates more problems than it solves. Today the trend is towards more flexibility. For example, office and instructional materials now are under one account. Guide lines have been tried but when you set minimum standards you have to argue for every additional cent requested. Minimums rapidly become maximums. With a rigid budget some departments end up spending wildly at the end of the year while another department may have critical needs. Each school has a general allocation based on the number of students. The principal must work within that amount and allocate funds according to his own judgement. There is some inequality here between large and small schools. I believe that small schools should have a higher per capita allowance. There should be some sliding scales.

4. What are your thoughts on teacher loads?

   I would like to see more time allowed for teacher preparation. I would hope that the class sizes in science would be leveled off as in English (25/class) and that the maximum for any teacher would be 125 students. The problem is not enough teachers. Each teacher should have at least one period for preparation each day and departmental chairmen at least two.

5. Would paid laboratory assistants be helpful?

   I would like to see it tried. The modern programs in science are very sophisticated and are far advanced beyond old cookbook methods. A great deal of preparation is needed as well as equipment and supplies. Student assistants are only partially satisfactory. They are not always capable or even available.

Appendix G-2 February 28, 1965

Summary of interview with Dr. Frederick L. Dunn, Principal of Robert E. Peary Senior High School.

1. To what extent should unscheduled activities or changes in schedules be allowed to interfere with the academic program?

   Any interruption is an interference. The degree depends on the philosophy of the individual teacher, his skills and familiarity with the subject - i.e. his adaptability. Some teachers would say that it was more important for a particular student to be involved in, say, a play or sports; this could be contrasted with another teacher who would find it intolerable if a student missed five minutes of one class. What we need is to cut down the number of hours teachers meet classes and interruptions would not be as frustrating. You can not meet the needs of students and have them in lock-step patterns at the same time.

2. How desirable is the scheduling of double periods for laboratory courses?

   Double periods have helped tremendously. It contributes to efficiency and has helped our audio-visual program. We are in our second year of a double period schedule on Tuesday and Wednesday. Students are in favor of it especially when teachers are flexible; double periods force teachers to be more flexible - to use more techniques, and be less monotonous. You cannot hold a class for two hours unless you are interesting. On the two days of double periods no interruptions in the schedule are allowed.

3. Should science departments be consulted for their financial needs in the coming year? How desirable is a budget or formula for science departments?

   The school is limited to a certain allocation per student. New schools are especially hurt for funds. It is a critical problem for us. For example, building up a classroom reference book collection. The text-book allotment is insufficient. Departments submit their needs and on that basis we allocate dollars.

4. What are your thoughts on teacher loads?

   They are entirely too heavy. We calculated the average work week sometime ago at fifty-one hours. This has been gradually increasing at a time when labor is striving for a thirty-five hour work week. With twenty-five class hours per week a teacher cannot prepare adequately. In the classroom, a teacher is subject to tremendous tension minute after minute and the pressure is constant. Pressure may reach higher peaks for a principal but at least he has times of rest. If you divided the number of pupil (actual) hours in class and co-curricular activities by 150, you would get what I consider to be the number of teachers needed in a school. This formula would about double our staff. I believe the school year should

be extended from the first of September through June and then every other Wednesday let the students out. This would give teachers more preparation time and would open up more time for community activities for students such as church and scouting, medical appointments. Teachers need more "thinking time."

5. Would paid laboratory assistants be helpful?

Students assistants are time consuming and a strain on teachers. I would be much in favor of paid assistants. I used to believe that a good teacher would require less administrative support but I have found that good teachers make far more demands - for example, they use counciling services far more. In business, a good man will use three times as many secretaries and turn out three times as much work. A good teacher actually needs more supporting staff than poor teachers.

Appendix G-4 March 5, 1965

Summary of interview with Mr. Earl P. Schubert, principal of Walter Johnson Senior High School.

1. To what extent should unscheduled activities or changes in schedules be allowed to interfere with the academic program?

   A school will, to a degree, reflect the community. Three-fourths of our students come from homes in which the parents are professional people and they have high academic expectations. It is my own personal belief that an academic program be kept as free as possible from interference. Assemblies are quite limited. We have a large after-school program, about 71 activities, and the scheduling of late buses permits every student to participate. In addition, there is a regular after school teacher assistance program.

2. How desirable is the scheduling of double periods for laboratory courses?

   Very desirable. But in a school that is 300 students over capacity, the shortage of classrooms makes it impossible. It took weeks of work just to schedule a double period for two experimental classes. Under the time limitations I am surprised that such an effective job is done in just the one period schedule.

3. Should science departments be consulted for their financial needs in the coming year? How desirable is a budget or formula for departments?

   I consult with my departmental chairmen every two weeks. The chairman is a professional leader in our community. The department indicates its needs and as far as possible we meet them. A large proportion of our science budget this year went towards the implementation of BSCS Biology. We try to follow guidelines set down by the science supervisor, Mr. Burk.

4. What are your thoughts on teacher loads?

   Out of a six period day I think a five period assignment is reasonable. We try to keep classes below the maximum recommended by the teachers. I would like to see the policy regarding English classes, a maximum of 25 students per class, applied to all academic subjects. However, I do not believe that 30-35 students in a class is unreasonable.

5. Would paid laboratory assistants be helpful?

   I have no experience with this situation. Our student assistants seem adequate.

Appendix G-5

March 10, 1965

Summary of interview with Mr. William W. Miles, principal of Richard Montgomery Senior High School.

1. To what extent should unscheduled activities or changes in schedules be allowed to interfere with the academic program?

   There are a number of unavoidable interruptions such as registration for classes, counseling, yearbook pictures and testing programs although I think there is too much testing and too little done with the results. Eight to ten assemblies a year, if well planned and educationally meaningful, are reasonable. Club activities are held after school. The policy is to avoid interruption of the day schedule and only those programs that cannot possibly be held at any other time are held during the regular school day.

2. How desirable is the scheduling of double periods for laboratory courses?

   Very desirable. However it creates difficulties such as for vocational classes which already have double periods and the work experience programs which only have classes in the morning. We are presently studying how to schedule double periods for those who want it and avoid giving it to those who do not want it.

3. Should science departments be consulted for their financial needs in the coming year? How desirable is a budget of formula for departments?

   Yes, definitely. The school gets a fixed sum based on the number of students. Departmental requests are honored as far as possible but funds never go far enough and distribution must be based on need. For any amounts over $10 we must go through purchasing.

4. What are your thoughts on teacher loads?

   I would like to see the class size limited to 25 students, but I think it should not go below 20. With smaller classes five classes a day is reasonable. We would hope that teachers with reasonable size classes could do a more effective job with the pupils. When we have the opportunity to give the teachers four classes, we would hope that they would utilize the extra time to the best advantage in helping other teachers in their department, and in helping to prepare other materials for their classes. They could also plan for better demonstrations, do some types of research, study for self-improvement, and find out more about their own pupils' problems. I feel that the greatest difficulty in attracting and retaining good teachers is the frustration they feel in not being able to meet the needs of students who lack the most basic of skills. Difficulty with reading is probably the most severe. I feel that a certification requirement should be a course in how to teach reading.

5. Would paid laboratory assistants be helpful?

   Yes, if the teacher would utilize efficiently any extra time this would give him. They may have student helpers if requested.

Appendix G-6

March 24, 1965

Summary of interview with Mr. Harold R. Packard, principal of Northwood Senior High School.

1. To what extent should unscheduled activities or changes in schedules be allowed to interfere with the academic program?

   Interferences should be held to a minimum. We have on the average about one assembly a month. This changes the amount of time in class only a few minutes. Sometimes assemblies run longer than scheduled but this is impossible to control.

2. How desirable is the scheduling of double periods for laboratory courses?

   If there is enough interest among the faculty, we will try it next year.

3. Should science departments be consulted for their financial needs in the coming year? How desirable is a budget or formula for departments.

   All departments should be consulted for their needs. We have no set budget for departments but each one submits its needs and we meet them as far as possible.

4. What are your thoughts on teacher loads?

   Science classes are too big. The maximum of twenty-five for English classes has increased the sizes of chemistry, physics and social studies about two or three students per class. I feel that twenty-five students per class is optimum although it would not be practical for us to talk in terms of smaller classes since we are over-crowded and could not accommodate the additional classes created by limiting all classes to twenty-five. The only way to add available classrooms would be to go on a split shift. I feel that five teaching periods a day is reasonable. Departmental chairmen had four periods before we had to tighten up.

5. Would paid laboratory assistants be helpful?

   I am not sure. We now have some student assistants. A paid person might save teachers considerable time.

Appendix G-7

Summary of interview with Dr. Daryl W. Shaw, principal of Walt Whitman High School.

1. To what extent should unscheduled activities or changes in schedule be allowed to interfere with the academic program?

   Interruptions should be kept to a reasonable minimum. It is important that teachers know ahead of time about changes in the normal routine. We try to limit any changes to certain days of the week, but even then this will be violated. On Friday, teachers know the next weeks schedule. Scheduled days for unit tests cause some hardships, i.e., each subject can test on only a particular day. This is our attempt to even out the testing load on students.

2. How desirable is the scheduling of double periods for laboratory courses?

   It is desirable, but impossible under the present set-up in Montgomery County. Most schools have a six period day since the State Board of Education requirement on period lengths would mean an extended day if seven periods are scheduled. I think we must have more flexibility to scheduling. However, I do not think the lack of a double period is as serious a problem in Biology as in the eleventh and twelth grade as more mature students should be doing more individual work. A double period would put time to better use.

3. Should science departments be consulted for their financial needs in the coming year? How desirable is a budget or formula for departments?

   There must be some kind of budget, although, we have not received figures from the Board of Education for allocation of funds. Although, some guide lines were published a few years ago, it would be helpful to have more up-to-date information. Each school receives a fixed amount for Materials for Instruction. We ask each department chairman to submit a statement of its needs. When a new laboratory is built, a special allotment is received for equipment. Funds for Materials of Instruction are insufficient, especially to do the kind fo work that science teachers wish. Although we have a chairman for the entire science department. to operate fairly, each discipline such as Biology and Physics should be represented by a sub-chairman.

4. What are your thoughts on teacher loads?

   Ideally I would like to see maximum class size established for all classes. In the sciences I would recommend a maximum of thirty-two in Biology, thirty in Chemistry, and twenty-five in Physics. I think a minimum size should be twenty. A five period teaching load is very heavy. If at all possible, science teachers should have their room free to work in.

5. Would paid laboratory assistants be helpful?

   They would be desirable, but I am not sure teachers would know how to use them. We have student laboratory assistants now, and they are helpful.

6. Have you found any particular problems with the new science programs?

   Text books are a problem as the allowance in Montgomery County is tight.

Appendix G-9

Responses of five Montgomery County high school principals to the question:

"Do you see any role for the Junior College in meeting needs of the school system?"

Mr. Thomas Conlon, Jr., principal, Albert Einstein Senior High School:

"I would like to emphasize the need of programs for teachers such as the 1964 summer program at MJC. A critical need is training for teachers of NCP Earth Science which is replacing Physical Science. Programs in curriculum implementation should be a function of the Junior College and teachers should be put on an eleven month salary to attend such programs. Perhaps, a person responsible to both the College and Board Offices could act in an advisory and coordinating capacity."

Mr. Harold R. Packard, principal, Northwood Senior High School:

"Advanced placement is meeting the need of a small group. I can see a possible role of the College in In-service programs for teachers."

Dr. Frederick L. Dunn, Jr., principal, Robert E. Peary Senior High School:

"We must reduce teachers' loads and provide more preparation time. The training of staff is more of a problem in the junior high where you find more inexperienced teachers."

Mr. Earl P. Schubert, principal, Walter Johnson Senior High School:

"I believe that MJC could provide the type of leadership and resources needed in the County for science education at all levels. You would find secondary schools and science departments looking upon the involvement of MJC with favor and enthusiasm."

Dr. Daryl W. Shaw, principal, Walt Whitman High School:

"I see the Junior College as a resource. Very good high school students are able to take advantage of the early placement program. The college should offer in-service courses, such as the recent BSCS program for biology teachers."

Appendix H

Staff

Robert B. Nicodemus, Director, Cooperative College-School Science Program. Assistant Professor of Biology, Montgomery Junior College. M.A.T., 1961, The Johns Hopkins University, B.A. 1956 The George Washington University.

Bernard T. Bridgers, Assistant Professor of Botany, Montgomery Junior College. M.S. 1952, University of Maryland. B.S. 1951, North Carolina State College.

Robert Wistort, Biology teacher, High Point High School, Hyattsville, Maryland. After September 1965--Biologist, Consultant for Scientific and Technical Intelligence Center, Department of the Navy. B.S. 1952 University of Illinois.

Advisory Staff

John K. Taylor, Director of Science Projects for the Joint Board on Science Education; Chief, Analysis and Purification Section, National Bureau of Standards. B.S. 1934 The George Washington University. M.S. 1936, Ph.D. 1941 University of Maryland

Bernice F. Pierson, Chairman, Department of Biology, Montgomery Junior College. B.A. 1928 Western Reserve University, M.A. 1937, Ph.D. 1941 The Johns Hopkins University.

Evelyn M. Hurlburt, Associate Professor, Bacteriology, Montgomery Junior College. B.S. 1938, M.A. 1939 Ohio State University.

Margaret H. Sickels, Assistant Professor, Zoology, Montgomery Junior College, B.A. 1942 Mary Washington College, M.S. 1951, Ph.D. 1954 Northwestern University.

Alan K. Roecklein, Coordinator, Radiation Science and Technology. Montgomery Junior College. B.S. 1962 State University of New York, L.I. M.S. 1964 Vanderbilt University.

Dr. J. David Lockard, Assistant Professor of Botany and Science Education, University of Maryland--AAAS Information Clearinghouse on New Science Curricula.

SECOND YEAR REPORT

COOPERATIVE COLLEGE-SCHOOL SCIENCE PROJECT*

THE JOINT BOARD ON SCIENCE EDUCATION

OF THE WASHINGTON ACADEMY OF SCIENCES

AND THE D.C. COUNCIL OF ENGINEERING

AND ARCHITECTURAL SOCIETIES

By

Robert B. Nicodemus
Director, CCSS Project

July 17, 1966

*Supported by a grant from
The National Science Foundation

Contents

General Description

The Cooperative-College School Science Project[1] of the Joint Board on Science Education is designed to assist local school systems in the improvement of science instruction. In a second year program[2], high school biology teachers worked with materials developed by the Biological Sciences Curriculum Study, and participated in a series of lectures, laboratories and seminars designed to provide additional subject background and practical techniques. The BSCS philosophy stresses student participation in laboratory experiments to discover what kinds of "answers" may be found, how the manner of search affects answers and how to evaluate results.

Two college faculty members and a high school biology teacher experienced with BSCS presented the summer program June 21-July 16, 1965, on the Takoma Park campus of Montgomery Junior College. Twenty-six teachers representing nine local school systems attended. The group met five days a week from 8:30 a.m. to 3:30 p.m. for a total of over 120 hours, exceeding the class time in a four credit college laboratory course. Over three-fourths of the time was in

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1. The word Program was changed to Project to avoid confusion with the NSF office. The first year report is available from University Microfilms, Ann Arbor, Michigan.
2. The first year program was very similar to the second with the exception of the use of "Green Version" BSCS in the summer of 1964, and the "yellow Verion" in 1965. Two BSCS "Laboratory Blocks" were also used in both summers.

laboratory with the remainder in lectures and seminars. Eleven local scientists lectured on areas of their research and work interests related to laboratory activities. The staff presented an almost identical program at Howard University, August 2-27, 1965. Participating teachers from D.C. public schools received graduate credit from the University.[3]

Following the summer program six informal meetings held on Saturday mornings at different schools afforded teachers the opportunity to observe different teaching situations, discuss problems and participate in additional activities designed to support laboratory instruction.

Recommendations for the improvement of Science instructions are made, based on an extensive evaluation of the two year Project. Two of the recommendations are being implemented through experimental programs conducted by Montgomery Junior College.

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3. Refer to Appendix E for the lecture schedule of the Howard University program. The laboratory was very similar to the one described on pp. 4-5 of this report.

Lecture Series

Cellular Ultrastructure
Mr. Thomas G. Merrill
Walter Reed Army Institute of Research

Current Research for Respiratory Virus Vaccines
Dr. Louis Potash
Flow Laboratories

Seasonal Control in Plants and Animals
Dr. Sterling B. Hendricks
Mineral Nutrition Laboratory
Agricultural Research Service

Diversity of Microbes
Dr. Harold E. Finley, Professor of Zoology
Howard University

Symbiosis and Parasitism
Dr. William O. Negherbon
Hazleton Laboratories

Mechanics of Transport Across Biological Membranes
Dr. Charles S. Tidbal l, Professor of Physiology
George Washington University School of Medicine

Nucleic Acid Interaction: A Molecular Approach to the Study of Genes and their Products
Dr. Ellis T. Bolton
Carnegie Institution of Washington

Radiation Biology
Mr. Alan K. Roecklein
Coordinator, Radiation Science and Technology
Montgomery Junior College

Population and Behavior
Dr. John Calhoun
National Institute of Mental Health

Social Implications of Population Change
Mr. Robert C. Cook, President
Population Reference Bureau

Biostatistics
Captain Douglas Tang
Walter Reed Army Institute of Research

Summary of Laboratories and Seminars

Laboratory exercises were organized primarily around the BSCS Yellow Version[1] and two laboratory books: Plant Growth and Development by A.E. Lee and Microbes: Their Growth, Nutrition and Interaction by A.S. Sussman[2].

The teaching of science as inquiry was continually emphasized by discussion. The presence on our staff of a high school teacher experienced and successful with BSCS biology enabled the realistic presentation of methods and procedures important in the inquiry laboratory. Many of the summer activities were organized in a manner similar to how teachers could conduct their own classes to illustrate techniques unique or difficult in BSCS.

The following summary of laboratory activities identifies only the beginning of topics, many of which were continued over one or two weeks.

First week, June 21-25, 1965

From the Yellow Version: cytoplasmic streaming and chloroplasts: interrelation of producers and consumers, Blue #40, a garden of micro-organism, use of dichotomous keys (participants received a copy of A Guide to the Study of Fresh-Water Biology by J.G. Needham. Holden-Day Press $2.50), enzyme action on a protein, factors influencing enzyme action, mitosis in plant and animal cells, squash and smear technique, pure cultures of micro-organisms, staining of bacterial cells, microbiological techniques, antibiotics.

From the Plant Block: tetrazolium and germination test, effect of environmental factors on germination, measurement and patterns of plant growth, internal changes in structure and organization of plants, changes in cells as they mature, cell and tissue organization, metabolism in growth and development.

Seminars: Chi-Square, N.I.H. electron microscope laboratory field trip, the idea of general knowledge and data.

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[1] Biological Science - An Inquiry Into Life. Harcourt, Brace and World.
[2] Published by D.C. Heath and Company.

Second week, June 28-July 1, 1965

Yellow version: Drosophila technique, inheritance of one-factor differences, independent inheritance, linkage and crossing over, sex-linked inheritance, diffusion through a membrane, heart beat of the Daphnia.

Plant block: mineral nutrition, relationship between a growth substance and phototropism.

Seminar: collection and analysis of data, chemoreceptors in man (from Green Version), the concept of causal lines.

Third Week, July 5 - 9, 1965

Yellow Version: heredity and environment, effect of reproductive hormones on cockerels, pituitary technique for reproduction and development in the frog.

Microbe block: yeast growth and use of statistics, colony growth of Rhizopus nigricans, effect of temperature on fungal growth, isolation of antisocial microbes.

Seminar: mathematics in biology, analysis of rates, degrees of equations.

Fourth Week, July 12 - 16, 1965

Yellow Version: conclusion of drosophila crosses, human respiration, selection and allele frequencies, Hardy-Weinburg distribution.

Microbe block: interaction of yeast and Neurospora crassa, Radioisotope uptake in plants survey with the GM counter, quantitative assay, autoradiography. (Radiation laboratory of Montgomery Junior College)

Seminar: evaluation and testing in BSCS programs the concept of functional parts, the whole as a determiner of its path.

Invitations to Enquiry

During the four week summer program, each teacher-participant was assigned for presentation one of the "Invitations to Enquiry" from the Biology Teachers' Handbook. J.J. Schwab, Supervisor. J. Wiley & Sons, Inc., N.Y. 1963. Each teacher was given a copy of this book. By their successful presentation of topics to the group of teachers, each participant was encouraged to utilize these aids in their own classrooms. The following invitations were presented:

Subject	Topic
The Cell Nucleus	Interpretation of variable data
Plant Physiology	Interpretation of complex data
Plant Nutrition	Control of experiment
Vitamin Deficiency	"If...,then...," analysis
Natural Selection	Practice in hypothesis
Auxins and Plant Movement	Hypothesis; interpretation of abnormality
Discovery of Anaphylaxis	Accident in enquiry
Disease and Treatment	Unit causes
Photosynthesis	Serial causation
Parathyroid Action	Multiple causation
Control of Pancreas	Diverse effects of diverse causes
Growth regulation in leaf	Nonlinear polynomial of degree
Simple examples of evidence of function	Seven evidences of function
Muscle synergism and function	Function in a system
Embryonic circulation	Persistance as evidence of function
Control of Blood Sugar	Maintenance of dynamic equilibrium
Blood Sugar and the Internal Environment	Fitness of models
Blood Sugar and Hunger	Homeostasis
The Stress Reaction	Interrelations of Homeostasis

Summary of the 1965-66 Academic Year

Follow-up Program

During six Saturday meetings[1] between October 1965, and May 1966, teachers met and discussed problems and programs with BSCS biology and participated in special seminars. Following is a brief summary of activities:

Comments on BSCS: Some common difficulties detracting from successful classes are lack of materials or funds, lack of laboratory assistants, short periods, large classes, difficulty in obtaining materials. There is considerable enthusiasm about the new Special Materials BSCS for slow readers. Teachers of SM Biology experience a degree of success with students never reached before. The involvement of students reduces discipline problems (but not the noise level with a dozen students doing things twelve different ways). The reading material is within the ability of the lowest levels experienced and assists students in the solution of problems unobtainable before.

Many teachers are conducting BSCS laboratories without the books. In the BSCS laboratory one begins with a question. and then investigates ways to answer it. Observation is stressed but more to support an understanding of how one obtains and evaluates information rather than arriving at one absolute "answer". When the validity of seeking information in various ways is accepted, one can expect different answers. Students who are upset in this uncertainly perhaps need this experience the most as they have become too dependent. The biggest problem is to get the student working in this climate of intellectual freedom and develop independent thinking. You may tell them

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[1] October 9, 1965. Calvin Coolidge High School, D.C.
Nov. 13, 1965. Northwestern High School, Hyattsville, Md.
Dec. 11, 1965. Geo.C.Marshall High School, Falls Church
Feb.12, 1966. Montgomery Junior College, Rockville
Mar.12,1966 Wheaton High School, Wheaton, Md.
May 21, 1966 Sligo Junior High, Silver Spring, Md.

their opinion is as good as any others (if based on accurate observation) but they will not believe it until the end of the year.

A particular value of the BSCS laboratory books is they provide a s tructured means to carry one particular investigation over an extended number of periods.

Seminars:

Availabilty of Parasitic Materials in Local Animals by Dr. William O Negherbon of Hazleton Laboratories. A wealth of materials was described such as Entamoeba in snakes, gregorines in the leach, balentidium in the caecum of guinea pigs, opelina, trichomonads and flukes (Halipegus, Gorgodera, Hematolechus)in frogs.

The Ecology of Intra and Extra Cellular Parasites by Mrs. Connie Wrench, American University. The examples discussed were Trypanosoma gambiense and Leishmania donovani. Teachers dissected a rat infected with Trypanosoma lewisi and prepared wet mounts of blood to study the flagellate. Stained slides of Plasmodia berghei were given to teachers.

Life cycle of Trichinella Spiralis by Dr. Leo Jachowski, University of Maryland. Mr. John Bergner assisting. A brief historical and economic description of the parasite was given. Teachers dissected a rat infected twenty-five days earlier for cysts in muscles and a rat infected six days earlier for adults in the small intestines. Encysted larvae were observed in abundance in press slides of diaphragm muscle.

Primitive Sex by Mr. Bernie Bridgers, Montgomery Junior College. Evolution of sex in plants was described. Teachers observed a sexual reproduction in chlamydomonas in the laboratory.

Structural Adaptation of Mosses and Ferns to Terrestrial Environments by Mr. Bernie Bridgers. Examined in the laboratory were Marchantia, Polystrichum, Horsetails and Ferns for gametophyte structure, hygroscopic nature of sporangia and spore dispersal.

The concept of using parasitology in general biology courses received considerable support at the November 9, 1965, meeting of the Helminthological Society of Washington. Many biologists at that time offered to present some

useful and important aspect of their field to a group of teachers. Although I regret we were not able to utilize very much of what was offered in our Academic Year Program, the possibility of setting up a separate seminar for teachers on this subject is very interesting. The greatest value would be derived from a laboratory program where teachers could receive practical experience on where and how to look for parasites, how to identify them, precautions and special techniques.

The importance of parasitology includes:

World Health - increasing travel places the problem of parasitism in any part of the world at our own doorstep.

Economics - parasitic infections account for tremendous losses in our own economy.

Concepts - parasite materials maybe used to demonstrate a variety of biological concepts such as ecology, vectorial organisms, pathology, hygiene, immunology.

Availability - infections in common animals provides an opportunity to use living specimens at very little cost.

Results

Teachers rated as valuable the combination of techniques, review of principles and survey of current knowledge in the 1965 summer program. Emphasis on laboratory work, about 75% (90 hours) of the total program, and the series of guest lecturers were well received.[4] Even though the Saturday morning follow-up program was beneficial, its effect was weakened by inconsistent attendance.[5] In-service programs involving week-ends, especially, can be more effective in a formalized arrangement where credit for certification or pay advance may be received. Teachers generally favored mor in-service programs similar to ones conducted under the CCSS Project.

After two semesters teacher evaluations of the summer program were even higher regarding its value and usefulness. In the same questionaire their statements regarding laboratory objectives revealed an awareness of teaching science as enquiry, thus affirming our continued emphasis of BSCS philosophy[6].

Teachers from the 1964 summer program provided similar descriptions of laboratory objectives and after two years rated the 1964 program with such remarks as "classes are

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4. Refer to Appendix B1-7
5. Refer to Appendix H4
6. Refer to Appendix H2-3
7. Refer to Appendix I2-3

better taught"..."tend more to have student find out for himself" and "I would not have attempted BSCS without it."[8]

Changes in teaching situations of the first year (summer 1964) group suggest influences of the CCSS Program. Although there was an over-all increase of students per teacher, as a group they gained in the number of student assistants and evidently were pleased enough with BSCS that fourteen accepted or obtained almost as many BSCS classes (47) as twenty-five of the 1965 summer teachers (53 BSCS classes). Accumulation of such results is, however, limited by the high turn-over. Already 20% of the first year group have left teaching.[9]

More than 40% of nineteen teachers from both groups rated one-half or less of their laboratories as achieving their ideal. This low number is related to two disadvantages: lack of time for preparation and class period and the lack of materials and supplies. The preparation of the laboratory is a time-consuming task when materials are to be placed in each student's hand. Work with live or perishable materials not only requires an adequate budget but also ease of obtaining materials when needed.[10] Similar complaints are expressed by administrators who also have their problems with inadequate budgets and overcrowding.[11]

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8. Refer to Appendix J3
9. Refer to Appendix J1, J5
10. Refer to Appendix H1-2, J1-3
11. Refer to Appendix G2

The CCSS Project stimulated the development of two long-range programs that may provide solutions for some of these difficulties. The Science Resources Laboratory concept has received considerable support from both teachers and administrators.[12] They have long recognized a need to have a local source of perishable materials that teachers may conveniently obtain. The idea is not without precedent, being firmly established and already successfully operating in the Los Angelese City Unified School District and in Baltimore County with a first year of operation at Dundalk High School. The Resources Laboratory to be maintained by Montgomery Junior College has a number of proposed phases: the first and most important being the supply of commonly used living materials to teachers, especially in the fall semester until teachers build up their own cultures. Even if the Resources Laboratory is successful, it will provide only a partial solution to problems of equipment and materials. A letter from the science supervisor of a large school system illustrates the problem of out-of-date lists and lack of planning.[13] With the necessity of administering large Federal grants, supervisors have little time left for such problems.

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12. Refer to Appendix H3-4, J4, I3
13. Refer to Appendix D

The second program is a Faculty Seminar Program designed to provide short intensive seminars for teachers at little or no cost. Two are planned for the academic year 1966-67. Teachers may receive "works.op" credit for attending but this is very limited for certification purposes.[14]

In three summer programs[15] we have found the combination of academic and practical experience to produce a program high in quality and meeting specific needs of teachers. If teachers a e going to teach up-to-date curricula, they will need better in-service opportunities. In a revealing letter froma high school teacher, the failure of curriculum designs is related directly at the classroom level to the "education of the science teachers themselves."[16]

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14. Three programs under the CCSS Project have received recognition as equivalent to four hours workshop credit for certificate renewal. The number of teachers who can use this type of "credit" is however limited. In addition, teachers from Montgomery County receive (1) workshop credit for qualifying for the Advanced Professional Certificate on the basis of the equivalent of a Master's degree (2) evidence of professional spirit for the renewal of the Advanced Professional Certificate, (3) placement on the MA 30 semester hours salary schedule" (from a letter by Gerald G. Reymore, Supervisor of Certification.
15. The 1964, 1965 programs for high school biology teachers have involved fifty-one teachers from ten school systems and three private schools. In 1966, a third grant from National Science Foundation is supporting over one hundred elementary teachers from seven local school systems and three private schools in a 3-week summer program plus six Saturday meetings. The cooperation of schools systems is considerably larger in this third program by their financial contributions. Needs of individual school systems are better met as they had an opportunity to recommend teachers for the program.
16. Refer to Appendiz C1-2

Recommendations

Recommendations in this second year report have been changed and reordered on the basis of information from teachers and administrators. Although the majority of principals responding to our questionnaire say they have sufficient information for the administration of science departments, more information was desired on needs for laboratory instruction.[17] Three of the following recommendations submitted to principals were supported by the majority.[18]

1. At least one double period per week should be provided for laboratory courses.

2. Number of classes should be limited to four in a laboratory program with a preparation area available at all times.

3. An adult laboratory assistant should be provided to keep inventory and assist in the preparation of materials.

4. A minimum of $3.00 per student for supplies alone should be avilable to biology teachers.

5. Living cultures and perishable materials should be conveniently available on short notice.

6. Local colleges and school systems should cooperate to provide quality in-service programs relevant to the teacher's work.

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17. Refer to Appendix G1-2
18. Refer to Appendix I1-2

Summary

The CCSS Project supported by grants from the National Science Foundation to the Joint Board on Science Education has in two years contributed significantly to science programs of Metropolitan area schools by:

1. Assisting the implementation of new and improved science curricula.
2. Successful combination of a lecture series by outstanding local scientists on areas of their own research interest with a laboratory program of practical use to experienced teachers.
3. Stimulation of two experimental programs offered by a community college in long-range support of science instruction. Through these two programs a charge by Dr. John H. Fisher, quoted in the first year CCSS report, is being fulfilled.

> It is only the long-run improvement that means much. In regard to teachers, it is of prime importance to communicate with them and to be concerned with helping them strengthn themselves. (January 27, 1964. Sheraton Park Hotel, Washington,D.C.)

Robert B. Nicodemus
Director, Cooperative
College-School Science Project

Cooperative College-School Science Program
Montgomery Junior College
Rockville, Maryland
20850

1965 Teacher-Participants and Schools

Howard County, Maryland

Mr. Marchmont A. Girod Glenelg High School Burnt Woods Rd., Glenelg, Md.	1119 Courtney Rd. Baltimore, Md. 21797 242-0133

Montgomery County, Maryland*

Mr. John R. Scott Northwood High School 919 University Boulevard, West Silver Spring, Md. 20901	14107 Heathfield Ct. Rockville, Md. 20853 Wh 2-5798
Mrs. Jean J. Maykuth Robert E. Peary High School 13300 Artic Ave. Rockville, Md. 20853	Rt. 1 Uppermont Lane Gaithersburg, Md. 20760 926-3604
Mr. Beuford L. Grigg Richard Montgomery High School Richard Montgomery Dr. Rockville, Md. 20852	Washington Grove, Md. 20880
Mr. Basid L. Kalandros Takoma Park Junior High Piney Branch Rd at Ray Dr. Takoma Park, Maryland	3421 Brown St., N.W. Washington, D.C. 20010 483-4710
Mr. James T. Simonitsch Sligo Junior High School 1401 Dennis Avenue Silver Spring, Maryland	5000 Bradley Blvd.Apt.22 Chevy Chase, Md. 20015 657-8933
Mr. Robert P. Burke Damascus High School Damascus, Maryland	1210 Thornden Rd. Rockville, Md. 20851 Ga 4-6455
Mr. Anthony J. Apicella Wheaton High School DalewoodDr. and Randolph Rd. Wheaton, Maryland	3417 Tulane Dr. Apt. 31 West Hyattsville, Md. 21234 Tel. 422-8434

Appendix A - 2

1965 Teacher-Participants and Schools

Montgomery County, Maryland

Mr. John S. Maykuth, Jr. Wheaton High School Dalewood Dr. and Randolph Rd. Wheaton, Maryland	Rt. 1 Uppermont Lane Gaithersburg, Md. 20760 926-3604

Prince George's County, Maryland

Mr. Jerre Kauffman Frederick Sasscer High School Upper Marlboro, Maryland	1131 Oak Hill Ave. Hagerstown, Md. 20870 Re 9-1613
Mr. Thomas L. Stickles Northwestern High School Hyattsville, Maryland	6839 Riverdale Rd. Apt. C 101 Riverdale, Md. 20840 277-3757
Mr. William H. Harris, Jr. Northwestern High School Hyattsville, Maryland	7713 Adelphi Rd. Hyattsville, Md. 20783 Ha 2-3457
Mr. Charles R. Kilbourne Suitland High School 5000 Sil Hil Road Suitland, Maryland	14038 Willoughby Rd. Upper Marlboro, Md. 20870 Tel. 627-3741

St. Mary's County, Maryland

Mr. Jacob A. Wright Great Mills High School Great Mills, Maryland	Box 278 Lexington Park, Maryland 20653

Washington, D.C. Public Schools

Mrs. Josephine R. Donovan Calvin Coolidge High School 5th & Tuckerman, N.W. Washington, D.C.	4524 Verplanck Place, N.W. Washington, D.C. 20016 Em 3-0649

Alexandria, Virginia

Mr. James B. Ford George Washington High School 1005 Mt. Vernon Avenue Alexandria, Virginia	1123 Greenway Rd. Alexandria, Virginia 22308 Tel. So 504638

Appendix A - 3

1965 Teacher-Participants and Schools

Fairfax, Virginia

Mrs. Irene B. Rousos Fort Hunt High School 8420 Ft. Hunt Rd. Alexandria, Virginia 22302	3547 Martha Custis Dr. Alexandria, Virginia 549-8529
Mr. Jack Stemple Herndon High School 224 Locust St. Herndon, Virginia	202 Park Terrace Cts. Apt. 13, Vienna, Virginia 22180 938-0204
Mrs. Carrie B. Janes Frost Intermediate 4101 Pickett St. Fairfax, Virginia	508 Shreve St. Apt. 13 Falls Church, Va. 22042 532-7294
Mr. Eugene W. Skinner Mt. Vernon High School 8330 Richmond Highway Alexandria, Virginia	1724 South 13th Rd. Arlington, Va. 22042 Ja 4-6737
Mr. Charles L. Coffman Mt. Vernon High School 8330 Richmond Hiway Alexandria, Virginia	202 Convair Dr. Alexandria, Va. 22306 765-6894
Mr. Charles T. Vizzini, Jr. George C. Marshall High School 7731 Leesburg Pike Falls Church, Virginia	3511 Leesburg Ct. #3 Alexandria, Va. 22302 481-7788

Falls Church, Virginia

Mrs. Alice M. Rooney George Mason Jr.-Sr. High School Leesburg Pike & Haycock Rd. Falls Church, Virginia	1117 Allan Ave. Falls Church, Va. 22046 Je 3-1937
Mrs. Violet D. Clark George Mason Jr.-Sr. High Leesburg Pike & Haycock Rd. Falls Church, Virginia	726 Timber Branch Dr. Alexandria, Va. 22302 Te 6-6409

* Dr. Henry N. Merritt, left Northwood High School to teach at Frostburg State Teachers College

Appendix B - 1

Teacher Evaluations of the 1965 Summer Program

1. Have you previously used BSCS materials? If so, have you found this program useful?

"I have found the program very helpful. Most of the material received this summer ' can use in my classroom for high school students."

"Yes, in a limited way. Especially in the use of Invitations to Learning. I plan to use more BSCS materials next year and I believe I will like it better - - over more areas not as yet tried. I shall go back with more confidence in the program since I have had this contact with BSCS."

"Yes. It is a much more stimulating course approach than the traditional one for the student and teacher."

"Yes - the lab emphasis, the inquiry! The student association and interest is 100% better."

"In many ways. The organization of the course has given me more time to spend on the actual class lab situation."

"Yes. It causes the student to think and I have been told by students that they are getting more from the BSCS than their friends in the regular biology."

"The program has been useful in that it provided methods and techniques as well as up to date research."

2. Has the program encouraged your adoption of BSCS materials? Would you have attempted BSCS without the summers experience?

"I have not used BSCS materials. I did review all three versions to help determine which version would be established in the curriculum. We did select the Yellow version and now I am more convinced that this was the best choice. Our BSCS teachers did not have the training experience and I was aware that the course was not operating smoothly. I was ignorant of the supplies and equipment really needed and the new emphasis on approach. Changes in the area of planning and organization must be made.

"Yes, the program has encouraged me to utilize the BSCS materials. I plan on incorporating the materials in my program starting this September. I definitely would not have attempted using BSCS materials next year without the experience of this Institute. In fact, we had many of the materials and texts for use last year, but I did not use them as I did not know the techniques to be used."

"The program has been a very valuable asset to me. I still have many questions in my own mind about the program as a whole, but will certainly adopt a part of it into my teaching."

"As I hoped, we have gone through a number of laboratory experiments ourselves and have evaluated them from various viewpoints such as statistically and pedogogically. I would not have attempted to use BSCS materials without such experience."

"The material and techniques learned during this summer program will enable me to conduct more and varied lab experiences. It also gives me the confidence needed to start teaching the BSCS program. I would have attempted to teach the program, since I have been assigned to teach four classes of BSCS green version; however, I am sure I would have been teaching it only as a supplement to the traditional biology and using the traditional approach."

"I would certainly adopt the BSCS materials because Ifeel that this course is more interesting to the students. I have seen it taught and the students that would not ordinarily be science minded or academically low, really enjoyed the course. They felt that they were more of a part of the class. I would have attempted using the BSCS materials, but after taking this workshop, I'm beginning to wonder how I fared without the wealth of information or different ideas..."

"Yes, I feel that I need more study before I could effectively work in BSCS; however, I plan to use the philosophy and some of the experiments in my class. As soon as my school can arrange to get the materials I want to be ready. I'm sure that I'll eventually use BSCS materials whether I get more formal study or not as I've always tried to basically practice this philosophy."

"Yes, I would have tried the method; however, I think I would have found it a mistake."

"I have been exposed to a limited amount of BSCS materials. I believe it would be useful if the BSCS program had a catalog with a brief description of the materials or literature, the price and where to purchase these."

"Yes, program has encouraged use of materials. Would try without this course."

3. What particular aspects of the program have you found especially useful and interesting? What changes would you recommend?

"I was delighted with each day's experiences. I brushed up on techniques, learned new ones, reviewed biological precepts and really learned the importance of updating chemistry course to make biology courses more meaningful."

"Lectures and seminars interesting; many new lab techniques useful; as to changes: more time to actually complete our lab work, thus giving me a more secure feeling of competency. The more techniques one can pick up, the better teache he becomes."

"....demonstration of techniques was important for me. Review of biological knowledge and extention of that knowledge to greater depth. I enjoyed the speakers particularly when they invited, as well as provided for discussion. Changes: I would have liked to carry those experiments we began to full conclusions. The loose ends bothered me. I can understand that time was short. Perhaps demonstrations by the instructor could have handled those activities which would not be feasible in the time allowed. I enjoyed very much the exchange of ideas with other teachers during the coffee and lunch breaks. Perhaps an informal hour or so could have made this activity more general."

"The experiments that do not require a lot of expensive equipment and/or great skill in manipulation have been most helpful. It was also interesting to see experiments requiring more elaborate set-ups. Lectures followed by laboratory exercises and demonstrations with the lecturer present to elucidate have been very interesting. On the whole, we have had outstanding lecturers that have in most cases reported some exciting, up-to-date developments in their fields. Their suggested applications of uses for class and practical applications of their findings have been very interesting as far as possible having more of the lecturers come into the laboratory should be extended."

"The participation in the lab experiments, and the fine quality of the instructors and topics selected for study."

"I think that this is one of the best Institutes I have ever attended."

"I found the lecture series especially interesting, but the exchange of ideas and by going over the laboratory experiments I found most useful for my classroom use."

"I like best the lecture and labs of Dr. Finley and Dr. Negherbon. A change I personally would like is a less hurried approach to the lab work."

"Laboratory techniques are useful - new materials and sources of information will be helpful, I'm sure. I'd like to see seminars added so that we could have an exchange of ideas particularly among the people who have worked in BSCS."

"Speakers from the research areas were very good. Lab work which could be duplicated in the classroom was excellent. More time for discussion of the BSCS philosophy would probably help those who had not been exposed to it."

"The many lab experiences provided by Mr. Bridgers will be most helpful in my teaching. More work on Animal Growth and Development, plus completion of experiments we undertake."

"Lab procedure. More practical applications and more time."

"The contact with the lecturers and with other teachers interested in BSCS was not only interesting but informative. More information given out as to technique and less time spent on incidentals."

"The lectures were very interesting (except the first which was way over my head). I think the lab experiences by way of followup to the lecturers. I particularly enjoyed Mr. Bridgers' lab periods. I would like to see more follow through. Even fewer exercises fully developed wou ld have more value than many lose strings. I believe the chickens, growth of the wonder beans, and Drosophila should be more emphasized and more carefully studied and with preparation as many or more teaching points could be developed."

"Each of the teachers did an excellent job. I have enjoyed this course more than any previous college course. The overall program was excellent. If we could have fewer labs, with more details on the ones used, it would be better."

"The program was a little hard pressed for time, and towards the end some experiments were not followed through."

"I found the lectures to be most interesting since they provided the opportunity to hear and question prominent men in fields related to the BSCS. It was very interesting to listen to someone present material that is now being taught in the high schools. The only changes I would like to see made are a closer correlation of lab material with text and some idea of the behind the scene preparation for lab. For example, how much time before hand should such and such be ordered or prepared, etc.?"

"Some techniques brought in by lecturers, new knowledge, handout of BSCS materials, names of economical supply houses."

"I have found the lab experiments to be very helpful and useful. Also the lectures were mostly very good. I would like to see it extended to take up more lab blocks and discussion to the text."

"...(a) lectures: giving more detailed knowledge into field directly involved with BSCS program. (b) informal discussions inducing free flowing thoughts. (c) invitations to inquiry discussions help give many view points and problems. (d) statistics lectures unless specifically asked, lecturer need not go into the derivation of involved math formulas."

"The program has centered itself on concepts (rather than facts only) which I consider more important. New labs, and the acceptance on the part of administrators of the lab book, have been especially useful."

4. In what ways might a Cooperative College-School Science Program prove useful to teachers?

"I found discussion of experiences with other teachers from the college and high school most helpful and productive. It is so easy to become isolated. The philosophy of science, techniques of teaching and problems that confront

teachers seem to be less awesome when we can discuss them. Education is moving in so many directions that one can become confused. I think it most important that a thought line is established between high school and college."

"...(1) help teachers to better communicate their needs. (2) develop a resource of reference material (3) give the school system a greater understanding of teachers problems."

"A central clearing source (it could be just a telephone number) could be available for teachers wanting a bit of information or willing to share other sources, ideas, materials, etc."

"Whether present programs or "reunion" conferences, or extensions of them can be multiplied feasibly, I do not know. However, the policy of "open lectures" during the CCSS program is a fine one."

"It will aid in keeping the high school teacher alert to the new trends and methods in the field of science and biology."

"This might require extra work, but a newsletter could be sent periodically to all previous institute participants with information concerning participants, their whereabouts or position etc. And also to publish teacher ideas and suggestions."

"Have follow up programs. Have in-service programs at night or on Saturday during the school year."

"Preparation of stock materials."

"Help the school board and other individuals who make decisions to understand the necessity for having spcific materials to produce quality teaching -- I don't think they're aware of the tremendous cost of materials or the value for having certain materials in order to follow through on new methods."

"Content courses in physiology (plant and animal) and other areas (biochemistry) would be very useful. Even people who have had such courses could probably benefit from them due to new knowledge in the fields."

"Double the length of time; doing more lab work. The teachers would appreciate receiving the money earlier in the program."

"Keep teacher up to date on: course available, new techniques, new materials, communication between schools and counties."

"An exchange of materials....original teacher innovations."

"The experience this summer points out the upgrading of science. We all too often become set in our ways and restricted in our approach. Now we see the new material and the approach and demands of science. It is always a fine thing to open and reopen minds that only too soon close to all but what goes on at this or that school or class. Any mixture of minds is far better than a man alone."

"The follow up programs offered to teachers are useful. The dissemination of prepared materials. The correlation of the program to the needs of the teachers as to certification, up to date methods."

"It would be interesting to see what is now offered to the undergraduate in science so that we may better prepare the academic student for college."

"To criticize techniques and improve on these. Update biology curriculum for systems."

"This could be used to bring teachers up to date on new materials and procedures."

"Getting speakers (such as Dr. Findlay) who can and will give material that can be used in the classroom is a way in which the program might be improved. However, the speakers selected here at M.J.C. were thebest I have heard in any institute."

5. What difficulties do you anticipate in your teaching next year?

"Programming courses. Utilization of lab facilities."

"Too large a class size; inability to obtain material; heterogenous grouping of classes.

"I will probably have traffic and material distribution problems in a lab situation. Dr. Hurlburt had apparently given some thought to this problem. Her lab went smoothly. There, of course, will be many other problems for me because I will need to depart from my own habit patterns before I embark on new ways."

"Unless the overall enrollment of my classes is smaller than last year, it will be exceedingly difficult for me to plan and execute a BSCS course, especially since it will be in only one class. The amount of time that I have to prepare for class laboratory work is limited and I cannot have regular laboratory assistants since no such arrangement is allowed in our building."

"Whether or not I will have sufficient time and equipment to carry out the aims of the BSCS program."

"I don't anticipate many difficulties. Maybe one would be that of equipment."

"Having enough equipment to put this BSCS program over the way it should be put over to the students."

"Not enough apparatus; not enough help in preparing labs."

"Lack of supplies or money for BSCS materials."

"Time to do what I would like as far as lab is concerned."

"Releasing my own pre-conceptions on what is fact and what isn't. Developing a research oriented situation will make next year most interesting."

"Takes time to organize and carry out the necessary preparation for a new approach (the green version); getting lab assistants."

"Possible lag in getting the materials when I need them. (This is local.)"

"Adapting myself and my students to the new material. Trial and error sort of thing."

"The only difficulty I can foresee is lack of proper prior planning."

"Enough time to complete the book and labs necessary for the program."

"Getting materials and getting them when needed are two difficulties which I will experience. Classes which are too large for lab work will be the most objectionable problem."

Appendix C - I

Excerpts from a High School Teacher's Letter to the Project Director

"...The most significant problem lies with the education of the science teachers themselves..I would say that at least half of them know biology primarily from a theoretical point of view. By this I mean that they have had the basic thirty hours in rock-bottom biology with run-of-the-mill laboratory experience that comes with these courses. They received a baccalaureate degree, and after that they took either education courses or some night lecture course to keep up with certification requirements. BSCS workshops and some radiation workshops are all that has been provided (in the county) in last half dozen years. However, lack of materials with which to work..has gradually doomed this to a few spotty continuing efforts in the high school instruction. BSCS is going to meet something of the same fate. Perhaps it's a matter of too much all at once, and not enough planning for a continuing program that has solid foundations...these noisy bandwagons should be ignored. Just because we rally to the hue-and-cry of the latest and most progressive educational ideas is no reason to count ourselves among the better schools of the nation...The real truth is that our surface looks good, but our long range program is lacking... Coming back to teachers -- you've got to stop giving them all these high fashion things, and get them back on the road toward a really good scientific training."

"The most necessary item for this solid scientific grounding is in their laboratory work. As you well know, the big cry of the BSCS program for real laboratory involvement floundered on all the multiple problems of trying to carry out lab work in inadequately equipped situations. Not only do we lack supplies (something your Resource Lab will help to improve), but we also lack knowledge. These teachers need to stop being accredited for night lecture courses, or purely run-of-the-mill courses in their subject field. They need the opportunity and stimulation to get their own hands dirty in research. This does not imply that they should get into research for the purpose of publishing papers and producing scientific data. What it does mean is that they should learn how to construct equipment and do research with whatever they can find at hand. If you told some teacher that they could use electrphoresis in the classroom if he only got a set-up, he

would probably ask how much one would cost. Given a price of $250 he would most likely forget the idea right there. If you said he could construct one himself with a little diligence, he'd say he had no extra time (and he reall y hasn't)...Time could be had if I were able to choose a course in practical workshop biology designed to help me in the classroom... We're all the time spouting off about getting students involved and interested in being scientifically resourceful, but I've yet to hear about anyone trying to accomplish the same thing with teachers, or indeed expecting it from teachers... they don't have this kind of background in DOing...We need more actual laboratory experience ourselves before we'll be able to guide the students in lab approaches.

"Just find a way to get that workshop moving and get those teachers in there to get their hands dirty. Get the teachers down to inventing. This is rock-bottom science. The biology teachers need it most. As for who is going to run the course -- don't start out looking for someone who knows all the answers to how to approach all the fields of biology, -- find someone who doesn't know any answers and only knows how to push faces into the mire and get muddy. If I don't miss my guess, you'll come out with teachers clamoring to scratch ahead in the classroom, and their enthusiasm will be infectious to stimulate others to follow the same course. Don't have a planned curriculum, whatever you do. Make your only plan one to simply get moving. (This is what the pedagogists refer to as "open-ended" research, but this is only what we're supposed to do to kids.!) Put no time limitations on any project other than the time it takes to complete a semester or a year. Let them construct, then experiment and employ what they've made. For every instrument constructed there should be at least a dozen uses. Trial and error will be a bulwark against pedancy. Then encourage idea-exchange meetings. In just the manner that BSCS stimulated teachers to try, discuss, and exchange ideas. In time such a program could be incorporated into a more national effort, such as NABT and NSTA."

Regards,

Appendix D

Excerpts from A Science Supervisor's Letter to the Project Director

"We do have lists of minimum standards for supplies and equipment for traditional biology. It is a product of teacher committee work, but individual teachers do not always agree with it. I agree that it is out of dat e, but on the other hand it is only suggestive, and we probably buy more materials which are not listed than those which are. For a couple of years we have been trying to compile some kind of list which is right for BSCS et al, as well as for traditional biology. So far I have nothing very useful - granted that we have all sorts of BSCS lists in suppliers catalogs. Our teachers are doing so many different things that common denominators are still obscur

"In recognition of BSCS work we have been purchasing larger incubators, refrigerators, stereos, etc., in goodly numbers. Our real problem is in knowing which teachers are going to do what in sufficient time to help them. Some of them believe that rabbits come out of hats. The issue is not so much related to money as to time and procedures."

"My office tries to provide funds for new programs and special equipment. Teachers who are able to comprehend this and to keep in communication with this office are usually taken care of..."

"We cannot always guarantee that teachers will have materials on sudden demand. Given time and cooperation, we can guarantee that all teachers will have what they need."

"We cannot provide individual teachers or departments with a drawing account, petty cash fund, or freedom to purchase f.om random sources. County procurement procedures require bids and/or quotes on all orders in excess of $100.00 and adherence to bid lists on most standard science items."

"The first year - or maybe the first few months are hardest. I would like to avoid the embarrassment of short supplies, but each situation is different, involving different people and things. I simply cannot outguess all of them. After all - it is their responsibility to make their needs known to us - in reasonable time and amount."

Appendix E

D. C. Public Schools-Howard University
Cooperative Program for Teachers of Biology
Department of Botany, Howard University
August 2 - 27, 1965

Lecture Series

Molecular Biology
Dr. Nicholas M. Kredich
National Institute of Arthritic and Metabolic Diseases

Oncogenic Viruses
Mr. Ted. Beddow
Flow Laboratories

Seasonal Control in Plants
Dr. Harry A. Borthwick
Agricultural Research Service

Photosynthesis
Dr. David Hammond
H oward University

Symbiosis and Parasitism
Dr. William O. Negherbon
Hazleton Laboratories

Diffusion and Active Transport
Mr. Andrew Goldner
The George Washington University
School of Medicine

Cellular Respiration
Dr. Roland M. Nardone
Catholic University

Inheritance of an Acquired Characteristic in Bacteria
Dr. O.E. Landman
Georgetown University

Evolution of Molluscan Shell Structure
Dr. Edgar Hare
Carnegie Institution of Washington

Radiation Biology
Mr. Alan K. Roecklein
Montgomery Junior College

Appendix F - 1

Teacher Evaluations of Summer Program
Held at Howard University, August 2-27, 1965

"It is my feeling that this summers BSCS program was successful. I believe that I derived much from the program along the lines of ideas to bring to my classes. The techniques learned were of value, especially since I did not teach the BSCS last year."

"Many of the exercises were too rushed to be able to derive the most from them. More equipment should have been made available so that we could have been better able to achieve our best."

"During the past four weeks, I have learned many helpful and valuable techniques and laboratory procedures which should aid me in teaching BSCS."

"I feel strongly that many of the procedures and techniques should be geared to the fact that we have fifty minute class periods. Some of the experiments should have been done in that short length of time."

"I think that this program has been very helpful, in addition to being enlightening to me. From what we have learned, and from the various experiments demonstrated, I am sure I will be better able to teach biology this year."

"The four week program was quite interesting, and I got a lot out of it. There were good ideas and I plan to use them in class. I think we did not have enough time to go as deeply as we should have in some places of more importance, and there was too much emphasis on non-essential problems, or ones that I knew before the institution."

"The program was very well organized in order to cover the materials that we did during a four week period."

"This institute was my first dealing with BSCS version of biology. I feel many of the experiments and data will be useful in the classroom. On the other hand a few basic points which are necessary in a 45-50 minute class were not taken into consideration. Time and preparation are most important and in a classroom cannot be taken for granted. In the institute all of the necessary materials were prepared for us. I think it would be better if the teachers were allowed to do this."

"On a whole I found the institute very enlightening. I feel, however, that much more could have been accomplished if some type of individual discipline had been used. Although this was a very informal class situation, I believe it was too much so -- therefore, work was at a lower production level."

"One of the greatest values that I saw in the institute was the ability of the instructors to design exercises which were meaningful for all of the teachers regardless of their background information. If this could be done in a class room all of the students would be motivated."

Appendix G - 1

Results of Questionaire Sent to High School Principals, August, 1965

	YES	NO
1. Do you have access to sufficient information for the administration of science departments?	9	2

2. What are the sources of your information? (Listed in order of importance)

Departmental chairman
Science supervisor
Faculty
Textbooks, journals
Curriculum guides
Administration
In-service meetings

3. In what areas is information on new science curricula needed?

"It might be helpful if the Science Supervisor would sit down in a meeting with all secondary principals and go over the many problems in the area."

"Not aware that information is lacking. Department members are participating in their own areas and hence take major responsibility for implementation of new programs. Sources of information listed above are sufficient to keep administrators briefed on new developments."

"Research on use and success."

"Need information on changed requirements for teachers and students, revised laboratory needs, etc."

"1. New equipement information is needed. 2. Experimental administrative procedures would help. 3. Comparative curricula would be helpful."

"I would like to be able to read a compilation of current articles or a breakdown in the form of a briefing article. This format is followed by Newsweek, the professors of School Administration also get out this type of briefing curricula which covers new information in the Field Quarterly. This type of publication would be most helpful."

4. What particular problems have you encountered in the administration or implementation of <u>new</u> science curricula?

"In general it has been obtaining materials and equipment. I think everything has been done by our local people but state and national programs require a lot of time. At first, personnel was a major problem, but their training has kept pace with change."

"Slowness on the part of the Supervisors to get things done."

"Budget limitations. But these are not believed to be serious. We are able to give solid courses built around new curricula within the framework of existing budgets...We have found it expedient (on trial basis so far) to retain some of the more traditional programs for students whose abilities do not allow success in some of the new programs such as BSCS."

"The summer BSCS program offered in the summer of 1964 at MJC was very helpful to the teachers who were introducing for the first time the yellow version at this school. A second year extension would be most desirable in biology and the inauguration of a comparable program in CHEMS and PSSC."

"Teacher attitude toward change. Supplies and facilities."

"Space and facilities. Financing."

"Very little except the overall difficulty of the school system in keeping up with population growth and its attendant demands on school facilities."

Appendix H - 1

Survey of Teaching Situations
1965-66 Participants

Specific responses to the question "How would you describe a successful laboratory? In your opinion what percentage of your laboratories achieve your ideal? What conditions assist or hinder you?

"A successful lab is one which allows the students to discover for himself what really happens instead of seeing it in a book or hearing about it. Lack of time, length of periods, lack of materials and size of class hinder me in lab work. The double period is a great help."

"Hindrances are (1) lack of time for preparation (2) period too short (3) ambitions of students (4) inability of students to read and follow directions."

"A successful laboratory is one which causes the student to think, gain some scientific understanding, and gain an insight into the concept to be illustrated. Previous ideas of students hinder -- they expect facts, black and white answers."

"A successful laboratory period is one in which an investigative atmosphere exists and one in which the students have the proper materials, proceed through their work with a minimum of guidance. The biggest hindrance is poor equipment or discipline problems."

"A successful lab is when students carry out their work farther than designated by the teachers. Too demanding of a load, 180 students, three different subjects, six periods a day, coaching baseball, plus taking a night class...my three biology classes do not all follow one another, consequently I must get materials out before each class then put them away at end of period so that I can teach another science class...."

"Lack of help - student assistans most often not available. A successful lab supplements; many times implements, but when one see dawning recognition of understanding, then I feel good and not quite so tired."

"A student centered lab instead of one that is class centered. The student moves at his own pace and arrives at his own conclusions independently. Ordered equipment and supplies are often delayed due to Federal aid (red tape)"

"Whenever the students are engrossed with interest and/or meaning of purpose in an experiment, I consider it to be successful."

Appendix H - 2

Survey of Teaching Situations
1965-66 Participants

"One in which the students complete the required procedure. 21 Interesting to most students. 3. Good student evaluation. 4. Excellent student response to followup discussion on lab applications."

"A successful laboratory is one in which the student understands why he (she) is doing what he is doing. One in which the student comes prepared and works with the team. Students are hindered by confusion of overlapping labs. What would help would be a double period."

Responses to the question: "From the perspective of this years teaching experience, please evaluate last summer's program."

"I think that I would not have been able to do well teaching the Yellow Version without the summer program. Not only did it give me the proper outlook, but also proper direction...I only regret that it wasnot longer."

"It really helped me."

"A revealing experience. You and your staff are to be congratulated on a well-planned and well balanced series of presentations. Many of the techniques learned have been employed during the course of the year."

"The lectures were very helpful in updating my knowledge. The lab work is even more important in adding variety to my experience and understanding of how to carry out these in my classes."

"...I was very favorably impressed with the caliber of instruction given by the staff at the college."

"It has been invaluable. I received a new concept of the BSCS program and I felt it has improved my lab work. The experiments conducted in the summer program gave me greater confidence and experience."

"Last summer's program helped me to realize that what I had tried to do in Biology was correct; that is, work with living materials and make biology come to life - but I appreciated the summer because it gave me direction, ideas, useful methods and techniques."

Appendix H - 3

Survey of Teaching Situations
1965-66 Participants

"Without it I would have been lost."

"What I could use of it was exceedingly valuable."

"My teaching has changed a great deal. The investigative approach really works."

"It has helped me the most through the new techniques, content and organization of labs."

"It helped my attitude to lab -- knowing what to obtain, realizing my own limitations, lab management..."

"It gave me and idea how to do it. I have utilized some of the sources of supply and speakers in my own classes."

"Mainly helped through lab tachniques -- raising root tips, chick ambryos, frog ovulation, germination."

"The contribution was great. It introduced me to BSCS materials..the BSCS approach to biology. Through using some of their materials and ideas I was able to teach a much better program in biology this year."

"Very good -- I learned some new techniques and became aware of various ways to modigy and elaborate my lab methods so as to make them more efficient."

"The speakers were informative and presented material that ties in with BSCS. Many times I have looked back at my notes in support of various topics being presented to my classes."

"Thank you for the fine CCSS project; it has helped me so much in my first year teaching BSCS."

Specific responses to the question: "Should your school system maintain a resource laboratory where you could conveniently obtain living materials and supplies?"

"Living cultures, small equipment items, etc. are always in demand. If you cannot obtain it at that time, the value of the lab experience has been lost. I believe the big system in Montgomery County is a great disadvantage to our science program."

Survey of Teaching Situations
1965-66 Participants

"I would like a place to buy those materials called for in the lab manuel where I could go to in one hour and not wait for two or three weeks waiting for and arranging because of late deliveries."

"This would make it possible to plan classwork better - now one must wait until things are in and arrivals are very indefinite."

"Our greatest problem is lack of space and help in maintaining those animals all year."

"Would help at times to have living materials when you really need them."

Specitic comments on the Saturday morning follow-up program conducted during the academic year 1965-66.

"The intent of the follow-up program is fine but sometimes it conflicts with such things as registering for classes or programs in the teacher's school...There should be a definite purpose...such as a correlated program."

"Based on reports, excellent. Due to previous committments I have been unable to attend."

"The excahnge between people from various school systems is most helpful as well as between various levels (High School and Junior High)."

"The ones I was able to attend were beneficial. I liked the discussion of current problems with other teachers."

"Of the few I attended, I found them to be interesting and informative..due to a busy schedule and personal limitations, I did not find it convenient to attend on Saturday."

"The discussions and presentations are beneficial because they keep the teacher up to date..and provide.. cooperative advice and assistance."

Survey of Teaching Situations
1965-66 Participants

	Biology Sections A	Number of Students (Average)	Student Assistants B	Double Periods	Expenditures C	Time in Lab Work	% Labs Satisfactory D
HOWARD COUNTY, Md.							
Marchmont A. Girod	1Y,2T	70(23)	3	3	1.10	70%	most
MONTGOMERY COUNTY							
John R. Scott	1B,2Ad	86(28)	4	0	2.00	50%	-
Jean J. Maykuth	5G	135(27)	3	1	0.89	60%	½
Beuford L. Grigg	4T	125(31)	0	0	-	30%	3/4
Basil L. Kalandros	-	-	-	-	-	-	-
James T. Simonitsch	-	153	0	0	-	20%	¼
Robert P. Burke	5T	101(20)	0	1	1.00	25%	-
Anthony Apicella	3G	90(30)	7	0	3.50	40%	3/4
John S. Maykuth	4G	130(32)	5	0	4.00	50%	-
PRINCE GEORGE'S CO.							
Kerre M. Kauffman	3T	85(28)	0	0	1.50	-	-
Thomas L. Stickles	5Y	152(30)	2	0	2.00	20%	most
William H. Harris	2Y,3T	150(30)	0	0	2.25	30%	¼
Charles R. Kilbourne	5Y	150(30)	2	0	1.00	30%	3/5
ST.MARY'S COUNTY							
Jacob A. Wright	3G,2T	170(34)	3	1	2.00	50%	3/4
WASHINGTON, D.C.							
Josephine R. Donovan	2Y,3T	160(32)	0	0	-	10%	-
ALEXANDRIA CITY							
James B. Ford	3G,1SM	100(25)	1	0	-	40%	-
FAIRFAX COUNTY							
Irene B. Rousos	4G,1T	150(30)	5	0	5.00	75%	-
Jack Stemple	1SM	-	0	0	2.00	40%	-
Carrie B. James	2T	60(30)	0	0	-	60%	-
Eugene W. Skinner	3G,2SM	120(24)	0	0	-	80%	-
Charles L. Coffman	4G,1Ad	116(23)	0	0	-	65%	½
Charles L. Vizzini	2G,2SM	98(25)	4	0	2.00	50%	1/5
FALLS CHURCH							
Alice M. Rooney	5T	100(20)	0	0	-	40%	-
Violet D. Clark	5T	125(25)	0	0	-	40%	2/3

Note: For explanation of letters A - D, refer to footnotes at bottom of Appendix J - 5

Appendix I - 1

Summary of Questions Sent to High School Principals and Science Supervisors

1. How desirable are the following recommendations made in the first year report:

a. A full-time paid laboratory assistant should be provided for every four teachers of laboratory science

Very desirable	6
May be desirable	4
Not desirable	3

Specific comments:

"No. These positions could be served by giving the teachers involved an equitable teaching load and student lab assistants during classes." (by a Junior High Principal)

"...would eliminate the need to worry about laboratory preparations...would be a great aid if the teachers used the extra time wisely...it could defeat the student laboratory assistant program and the guidance provided by teacher-student relationship." (Senior High Principal)

"This sounds more idealistic than realistic. If the same recommendation came from several subject areas, it would result in a considerable increase in the budget..."(Sr. High Principal)

b. The number of classes a teacher is assigned should not exceed five for one preparation or four for two different preparations.

Agree	10
Disagree	2

Specific comments (by Sr. High Principals):

"...any laboratory course teacher should have only four classes regardless...this is not feasible at the present time when the number of teachers is limited to a fixed teacher-pupil ratio."

"...the number assigned should not exceed four for one preparation...unless an aid is hired to assist..."

"Impractical in smaller schools."

c. A Minimum of $3.00/student for supplies along should be allotted for biology.

Agree	8
Should be more	0
Should be less	3

2. How valuable has this Cooperative Program been to your school or system?

"Only one of our teachers has participated in this program. He incorporated BSCS ideas and materials into his presentation and he is satisfied with the results. Next year he will be resource teacher and that is when we expect the course to pay dividends."

"This program has been quite valuable to the two teacher especially in regards to knowledge gained and techniques learned."

"The Cooperative program has been a great asset to the science department. Methods and techniques learned through the program have been successfully implemented.

"Mr. Girods approach has changed from lecture-demonstration to a lab-oriented approach. This has resulted in much more motivation of the student. In our county fair Mr. Girod's biology students took first place in the Botany, Zoology and Medical Science divisions plus numerous runner-up awards. This is a direct result of attending your Cooperative program."

"...a valuable experience to Mrs. Rousos. She became acquainted with the cellular approach (Yellow BSCS version) to biology... She also learned ways of modifying and bettering various techniques and procedures used in the classroom."

"The new method of teaching used by teachers who have participated in the program seem to stimulate interest in the course. It is also valuable to the teacher, helping her and giving her confidence in her presentations."

3. Should there be available to your teachers a local source of commonly used living materials and supplies maintained by the school system?

Yes	9
No	3

"Our system is not large enough for these services."

"The Junior College would be an ideal location for a source of commonly used living material...This source of materials would preclude time delays in ordering and also save money, but the biggest value could be in that the materials would be handy -- consequently teachers would use them."

"...would be ideal and would alleviate the problem of ordering certain li e materials that are hard to come by when needed, such as incubated eggs."

"Our system is not large enough for these services."

"Since our school only offers Human Biology at the 7th grade, I do not feel that this would be of an advantage."

"Our system is too small."

"This sounds practical for a system the size of Fairfax County."

"Yes, if they can get these when they need them."

Appendix J - I

Follow-Up Study of 1964-65 Teacher- Participants

In the academic year following the 1964 Summer Program, all but one[A] of the teachers returned to their classrooms. This past year, two went into administration (Mr. Pearson and Mr. Ramsay), one took maternity leave (Miss Murhpy - now Mrs. Monkman), and one went into graduate school (Mrs. Wrench) but plans to return to teaching this year. Next year we shall lose at least one more from teaching - Sister Cecilia will become Mother Superior of Georgetown Visitation.

Of the thirteen situations compared, five teachers had an increased number of sections of BSCS biology. Three teachers had significant increase in number of students (44, 23 and 22 more for Mr. Morris, Mrs. Richardson and Miss Smith respectively). Three teachers had significant decreases (10, 37, and 13 for Mr. Burgee, Sister Rosamystica and Mrs. Dryer respectively). As a group there was an over-all increase of 3.5 students per teacher.

Five teachers had an increase of student assistants while three lost some. As a group, there was a total increase of 7 student assistants or about ½ per teacher. Only one additional teacher (Sister Rosamystica) was provided a double period this past year.

Number of participants	26
Number not teaching	5
No response	7
Number returning questionnaire	14

Responses to the question: "How would you describe a successful laboratory? In your opinion, what percentage of your laboratories achieve your ideal? What conditions assist or detract from achieving your ideal?

"One which inspires and excites the students to further study and inquiry. Maybe 25% of the labs achieve this ideal. My own experience and NSF studies assist me in working for successful labs. Lack of equipment and supplies are the biggest hindrances."

[A]Mrs. Griffiths is working at N.I.H.

"One which is challenging - - allows opportunity for inquiry and student inter-discussion. Lack of time is the biggest problem."

"Most of my labs are the quick and easy type to prepare because I lack preparation time."

"All of my labs are successful. The greatest assistance is having the necessary materials available to carry out the labs when needed."

"One which the students enjoy. Although most are successful, there is not enough time in one period."

"The successful laboratory is one where students are 'getting the answers' by investigative techniques without a great deal of help from the teacher. It is one where students learn to extract data..During the start of each year, it is a problem to teach data 'taking and analysis'. They fortunately develop better techniques as the year evolves."

"A successful lab. would (a) provide adequate time for student involvement, (b) provide sufficient equipment and supplies for each class, (c) have convenient outlay for preparation; (d) provide adequate time for teacher, students/aids, prepare materials for use (e) have available cash for immediate procurement of some items without so much red tape. "None of my laboratories achieve this goal."

"To be a success, a laboratory session must involve the active participation of each student in some facet of the work. Each pupil must realize his role in the work of the team or class, and in an experiment, must be able to see results and draw conclusions. In the process of the experimental procedure, teacher guidance in scientific and social skills,challenge to the gifted, and encouragement to the slow student is a requisite. I find it impossible to give the necessary amount of individual guidance to students which could help insure active participation on the part of each one in a forty minute period with approximately forty students."

"One which the student becomes interested in what is being done and works toward accomplishing this. Labs are crowded and all are single periods.

"That my students become independent of me..give them every opportunity to answer their own questions..The fact that over 50% of my students did not have a science course in the 9th grade has been a hindrance."

Responses to the question: "What long range effects can you identify from your participation in the 1964-65 CCSS Program?

"I hope that my classes are better taught as a result. I think so myself."

"I know what to do to get ready. I am much better prepared going into a class as a result."

"I hope the students are beginning to question and search, and I have found out that I lack a great deal of training."

"Better lab techniques and ideas. Also the more modern up-to-date BSCS philosophy."

"It was of great value to understand the BSCS approach to biology."

"It was quite helpful. I used some of the same sources and speakers in my own classes."

"1. Better organized for course content and integration of lab work. 2. Learned how to use the data book. 3. Learned to improvise in the laboratory."

"Newer presentations of Kingdoms..an attempt to present broader concepts unifying basic concepts for all organisms; an attempt to emphasize the importance of ecosystems... tend more to have student find out for himself...There is a tendency away from much anatomy."

"As a result of that wonderful 1964 summer program, I have found courage to attack new materials and methods, profited from practical experiences in lab techniques and procedures, made an attempt to present latest scientific findings to students, and have been willing to learn with them. It was a privilege to share the insights of other biology teachers, and fun to form friendships with a great group of people."

"A broader outlook. Actually I think more interest because the approach as more of a challenge. Having been in the field for many years, one tends to get in a rut. I am

glad I was in the program and have had an opportunity to work with the materials."

"1. Greater emphasis upon Plant Physiology and Plant Ecology. 2. More time devoted to group discussion of experiments."

"Tremendous amount of benefit. I would not have attempted teaching BSCS without it. Going over material very helpful. The variety of lectures was very stimulating."

Response to the question about desirability of maintaining certain living organisms was a unanimous 'yes'. Some frequently listed as desirable were bacterial culture, protozoa, hydra, planaria, crayfish, daphnia, fruit flies, chemicals too expensive to buy in small lots, micro-slides, algae, fertile eggs.

Survey of Teaching Situations
1964-65 Participants

	Biology Sections A	No. of Students (Average)	No. of Assistants B	Double Periods	Expenditures C	Time in Laboratory Work	% Labs Satisfactory D	Use of "Invitations"
MONTGOMERY COUNTY								
Northwood High School								
Mr. Morris	5Y	170(34)	0	0	0.90	50%	¼	often
Robert E. Peary High								
Mrs. Richardson	1Ad	25(25)	0	1	0.89	75%	most	few
Mr. Campitell	5Y	135(27)	5	1	0.75	30%	-	few
Walt Whitman High								
Mr. Nichols	2B,3T	180(36)	2	0	?	35%	-	few
Walter Johnson High								
Mr. Burgee	5B	150(30)	2	0	2.00	60%	all	no
PRINCE GEORGE'S CO.								
Fairmont Heights								
Mr. Barnes	1B,4T	140(28)	4	0	2.00	40%	3/4	often
Frederick Sasscer High								
Miss Smith	2Y,4T	180(30)	1	0	2.00	50%	4/5	few
FREDERICK COUNTY								
Lingamore High								
Mr. Hummer	2G,1Ad 3SM	148(24)	12	0	1.78	70%	-	often
D.C. PUBLIC								
Springarn High								
Mrs. Johnson	1G,4T	147(28)	1	0	1.02	40%	-	few
PRIVATE								
Georgetown Visitation								
Sister Cecilia	3G	66(22)	3	2	-	-	-	no
LaReine								
Sister Rosamystica	5 G	175(35)	1	1	7.42	50%	few	few
ARLINGTON COUNTY								
Washington-Lee High								
Mrs. Dryer	4Y,1SM	120(24)	0	0	2.00	40%	-	no
FAIRFAX COUNTY								
George C. Marshall								
Mrs. Hanzal	5 G	137(27)	0	0	2.25	60%	½	few
Jefferson High								
Mr. Firebaugh	3.G	86(28)	10	0	-	65%	-	few

A G(green version), Y(yellow version), B (Blue), SM(Special Materials (BSCS), Ad(2nd Year Biology) T(Traditional)
B For one period each
C Per student for supplies
D The question: "In your opinion, what percentage of your laboratories achieve your ideal?"

Staff

Robert B. Nicodemus, Director, Cooperative College-School Science Program. Assistant Professor of Biology, Montgomery Junior College. M.A.T., 1961, The Johns Hopkins University, B.A. 1956, The George Washington University.

Bernard T. Bridgers, Assistant Professor of Botany, Montgomery Junior College. M.S. 1952, University of Maryland. B.S. 1951, North Carolina State College.

Robert Wistort, Biology teacher, High Point High School, Hyattsville, Maryland. September 1965-66 -- Biologist, Consultant for Scientific and Technical Intelligence Center, Department of the Navy. B.S. 1952, University of Illinois.

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THIRD YEAR REPORT

COOPERATIVE COLLEGE-SCHOOL SCIENCE PROJECT*

THE JOINT BOARD ON SCIENCE EDUCATION

OF THE WASHINGTON ACADEMY OF SCIENCES

AND THE D.C. COUNCIL OF ENGINEERING

AND ARCHITECTURAL SOCIETIES

By

Robert B. Nicodemus
Director, CCSS Project

July 1967

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GENERAL DESCRIPTION

The Cooperative College-School Science Project of the Joint Board on Science Education is designed to assist local school systems in the improvement of science instruction. In four summer programs and academic year follow-up activities over two hundred elementary and secondary teachers have been introduced to new science curricula and related college-level content in laboratories and lectures.

In a full-time three-week program on the Rockville Campus of Montgomery Junior College June 27 - July 15, 1966, over one hundred elementary teachers from the Washington Metropolitan area worked with three units of Elementary Science Study -- Kitchen Physics, Small Things and Behavior of Mealworms. They also were introduced to materials from three other science curriculum developments -- "Science - a Process Approach" of AAAS, "Quantitative Elementary School Science" of Dr. Clifford Swartz, and "Inquiry Training" of SRA. The group met for a total of over ninety hours of laboratory and lectures.

Six college faculty and six science resource teachers worked full-time with the teacher-participants. In addition, two teachers conducted a morning demonstration class in which elementary students worked with the ESS materials.

An extensive planning program conducted during the spring semester contributed to the success of the summer program. Activities consisted of visits by the staff to elementary schools in Montgomery County where ESS units were being taught and a series of four sessions conducted by ESS staff.[1]

Following the summer program a series of six Saturday sessions provided additional back-up for teachers working with the ESS materials. In addition, twenty teachers participated in a pilot project to evaluate effects of teaching the materials. Analysis of these results will continue into the fall of 1967 and will contribute to a continuing evaluation program of Montgomery County Public Schools.

[1] Refer to Appendix E

Science Seminar Schedule

Monday, June 27

8:00 Coffee
8:30 Introductions
9:00 Getting Acquainted with Science - Dr. Albert F. Eiss, NSTA
10:30 A, B * Optics I, Hydrostatics
C, D * Science - A Process Approach
1:00 Constructing a Simple Microscope
to 3:30 Kitchen Physics - Time to Empty

Tuesday, June 28

8:15 A, B Hydrostatics, Optics I
C, D Compound Microscope
10:15 Properties of Matter - Dr. Susan Thornton
12:30 Making Things Look Larger
to 3:30 Kitchen Physics - Time to Empty

Wednesday, June 29

8:15 C, D Optics I, Hydrostatics
A, B Compound Microscope
10:15 Optics - Dr. Peggy Dixon
12:30 An Onion - Levels of Seeing
to 3:30 Beading of Water Columns

Thursday, June 30

8:15 C, D Hydrostatics, Optics I
A, B Science - A Process Approach
10:15 Cell Ultrastructure - Dr. William Fleming
12:30 Different Cells - Same Plant
to 3:30 Beading of Water Columns

Friday, July 1

8:15 A, B Crystals, Optics II
C, D Plant Cells
10:15 The Art of Questioning - Illa Podendorf, The Laboratory Schools, University of Chicago
12:30 You - Instead of the Onion
to 3:30 Kitchen Physics - Interpretation

* Letters A, B, C and D designate groups into which participants were divided for laboratories

Tuesday, July 5

8:15 A, B Optics II, Crystals
C, D Cellular Organization
10:15 Crystals - Dr. Peggy Dixon
12:30 Heaping and Drops
to 3:30 Pond Water

Wednesday, July 6

8:15 C, D Crystals, Optics II
A, B Plant Cells
10:15 Ecology of a Pond - Mr. Bernie Bridgers and Dr. Robert Frieders
12:30 Tensiometer Experiment
to 3:30 Pond Water

Thursday, July 7

8:15 C, D Optics II, Crystals
A, B Cellular Organization
10:15 Cell Structure and Function - Mr. Bernie Bridgers
12:30 Tensiometer Experiment
to 3:30 Protozoa

Friday, July 8

8:15 A, B Boyle's Law, Molecular Phenomena
Surface Tension, Capillary Action
C, D Fresh Water Biology - Identification Key
10:15 Dichotomous Keys - Dr. Robert Frieders
12:30 Kitchen Physics, Tug of War
to 3:30 Behavior of Mealworms

Saturday, July 9

9:30 Outdoor Laboratory Programs, Arlington County Public
to 2:30 Schools Outdoor Laboratory, Clifton, Virginia

Monday, July 11

8:15 A, B Molecular Phenomena, Boyle's Law
C, D Freshwater Biology
10:15 Lower Plants and Animals - Mr. Bernie Bridgers
12:30 Kitchen Physics - Tug of War
Looking for Cells
2:00 A Quantitative Approach to Elementary Science - Dr. Clifford Swartz, Department of Physics, State University of New York, Stony Broook

Tuesday, July 12

8:15 C, D Boyle's Law, Molecular Phenomena
A, B Freshwater Biology
10:15 Animal Behavior - Dr. Robert Frieders
12:30 Looking for Cells
Kitchen Physics - Evaluation
2:00 Science in the English Educational System - Mr. Lawrence Wilcox, Newcastle Upon Tyne, England

Wednesday, July 13

8:15 C, D Molecular Phenomena
A, B Freshwater Biology
10:15 Water - Dr. Peggy Dixon
12:30 Kitchen Physics - Evaluating
Small Things, Behavior of Mealworms
2:30 Alternate

Thursday, July 14

8:15 A, B Mechancis of Liquids, Bernoulli Principle
C, D Cell Growth
10:15 Fluids - Dr. David R. Gardner
12:30 An Experimental Evaluation Design -Mr. Robert B. Nicodemus
2:00 Teaching the Pursuit of Science -Dr. J. H. Woodburn, Montgomery County Public Schools

Friday, July 15

8:15 C, D Mechanics of Liquids, Bernoulli Principle
A, B Plant Behavior
10:15 Soap Bubbles - Dr. Susan Thornton
1:00 Inquiry Training - Dr. J. R. Suchman, Science Research Associates
3:00 Summary and Evaluation

Summary of Afternoon Sessions* on Small Things
(Prepared by W. Gilmore Smith)

June 27

Built miniscope kits satisfactorily in 1½ hours. One group did not follow directions (dittoed) with the care of first group. Both groups recommended each step be pictured on the instruction sheet, and that in actual classroom situation the children should all do one step at the same time.

June 28

Checked final construction and made several adjustments and improvements. Variables accounting for difficulties discussed. Study of lenses including water drops, hand lenses and miniscope lenses. Charted characteristics of lenses ("Making Things Larger"). Concept of transparency and curvature-magnification result of perspective involving distance object was observed.

Examined small substances such as powders and particles in room. Noted general effects of magnification (field size, distortion, working distance). Compared simple microscope to compound.

June 29

Philosophy of unit "A Look at the Onion" identified and discussed with specific reference to role of materials including laboratory sheets as guides when necessary. Made onion skin slides following use of whole onion examination, disection, recording. Identified technique of slide making, including difficulties. Detailed and careful observation assisted by some stains. Food stain not especially helpful.

Discussed concept of cell in terms of size, shapes, and their relation to source of cell specimen.

June 30

"Different Cells from Same (and Different) Plants". Looked at different parts of onion bulb with and without stains. Methlene blue and Iodine best. Onion roots did not make good enough slides by the squash method, but Duckweed provided interesting comparison in root tips. Onion leaf, holly, sedum were examined and provided good comparisons revealing new cell types to many teachers.

Teachers examined cross section and longitudinal section of celery, potato, tomato, green pepper, apple, watermelon rind and

* Each session was 1½ hours in length.

carrot as produced with a simple micro-slicer.

July 1

Demonstration and discussion of cell differences in wet mounts. Developed ideas for unit of measure. Hair mentioned but felt by some to be poor as "would not be of consistent width". Accepted this as idea and challenged speakers to provide evidence to support it. Nylon thread suggested and later tried and found very good. Measured cells and other things. MM plastic ruler used successfully was was fine graph paper and ball point dots and circles.

July 5

Examination of life found in pond water. Sharing and discussion of similarities and differences among pond micro-animals and plants such as euglena. Described sizes, shapes, colors, apparent complexity and locomation.

July 6

Examined pure cultures and discussed means of raising micro-animals. Examined Daphnia as example of multi-cellular organism. Identified organs of Daphnia. This animal makes a wonderful climax to study and affords children opportunity to see not only a high degree of differentiation of body parts in function and form, but they can also see cellular structure of Daphnia's body cover plates.

July 7

Continued study of micro-animals and stressed importance of descriptive observation in classes.

Discussed periodicals providing over-view and analysis of aspects of philosophy, especially creative teaching and problem solving.

July 11

Made wet mounts of eight different parts of a fresh whole chicken (uncooked). No one saw cells except from liver. Examined leaves of sedum.

July 12

Evaluation session (45-minute period). Very worthwhile as there

was a real give and take and identification of philosophy in terms of behavior indexes, content, reporting (notebooks and note-taking), and the so-called "scientific method".

Examination of yeast. Gride from woven nylon fabric (apron) material very successful.

July 13

Evaluation (45-minute period) as above.

Summary of Afternoon Sessions* in Kitchen Physics
(Prepared by Alton Enderson)

The idea of presenting Kitchen Physics to teachers just as we would expect them to present it to their children proved to be an exciting challenge.

The teachers were not willing (in the beginning) and were not able to adapt readily to this type of an approach. They wanted "scientific reasons" presented prior to the actual experimentation. They insisted on knowing what they were to do and what results we expected before beginning to work.

The teachers received only the simple materials, and very informal instructions on how to use them. They were turned loose to experiment, observe, record and classify data in any method or manner they chose. (We hope they will use this approach with their children).

The teachers could not readily accept this procedure. They had been conditioned to the idea that when you conduct an experiment with children you must first, know the answer; second, mock the experiment; and third, come up with the right answer. This method is not a sound approach. It is simply a rehash of some known experiment, with a simple result, based on a concrete fact, to be "taught" to children as science. If we want facts of this nature, let them read it out of a textbook, instead of wasting time doing experiments that are not meaningful in the teaching of science. Our task was to try to change this type of an approach to the teaching of physics.

The teachers in the summer seminar became extremely frustrated with this kind of approach, but the frustration had its advantages. It prodded them into a state of wanting to work, to see if they could come up with a correct answer (of which there was no one correct answer). They found out that every result was as valid as any other as long as the conditions were identified.

There were still some skeptics. I'm sure that some teachers will return to their classrooms, give the children specific instructions, based on so-called "scientific principles", show them how to do the experiments and wonder why their children lack enthusiasm and the program is a failure.

Most teachers became very adept (just as the children will) at using the materials and made remarkable progress in the "process approach" by the end of the summer seminar.

These are some of the comments made by the teachers:

"The materials are simple, easy to acquire, easy to use and can be manipulated by each child in the classroom, instead of being demonstrated by the teacher. All children

can participate. The slow groups will not become as refined in their observations, but still they can easily observe what is happening. The better groups can explore deeper, faster and more complex materials and happenings, that can extend and enrich their scientific backgrounds. In this type of material, "the sky is the limit" as to how far, how fast and how deep the children will want to become involved."

"Science for the elementary child should not be a burden, but should be a natural step in exploring the world around him. He must build from a simple, uncluttered beginning to a complex, refined, enlarged and enriched understanding of science and life around him."

"The Kitchen Physics unit lends itself very conveniently to this goal. The child is not burdened with complex equipment. He is not burdened with a technical vocabulary that he doesn't understand. He is not watching a teacher lecture and demonstrate an already known conclusion and calling it an experiment."

Academic Year Program 1966 - 1967
Meeting 9-12 A.M.

TOPICS

October 8, 1966-----Phenomena in Physical Optics
Lecture by Dr. Peggy Dixon on electromagnetic radiation and light phenomena. Demonstrations by Dr. Frank Verwiebe, illustrating (1) interference by Young's double slit experiment, (2) diffraction by single slit and diffraction grating, (3) wave length by Michelson's interferometer and (4) polarization in reflection, refraction and absorption.

November 5, 1966-----Fresh-Water Biology and Pond Ecology
Lecture by Mrs. Connie Wrench on pond ecology. Laboratory by Mr. Bernie Bridgers on identification of fresh-water plants and animals with emphasis on aquatic fungi algae.

December 10, 1966---Minerals
Lecture and laboratory by Dr. David R. Gardner. Origin and historical significance of minerals, relation to rocks, diagnostic characteristics, hardness scale.

January 14, 1967----Rocks
Lecture and laboratory by Dr. David R. Gardner. Rock cycle and classification, geology of the metropolitan area.

February 11, 1967---Science Teaching with Topical Fish
Lecture and laboratory by Dr. Robert Frieders. Setting up and care of an aquarium, experiments with guppies - growth and embryology, ecology, behavior, reproduction, genetics.

March 11, 1967------Lower Plants
Lecture and laboratory by Mr. Bernie Bridgers. Life cycles of slime molds, true fungi, algae fungi, photomicrography of growth and reproduction.

During the sessions there was also discussion of evaluation in elementary science conducted by Mr. Robert B. Nicodemus.

This seminar was supported by a grant from the National Science Foundation to the Joint Board on Science Education.

PRODUCTION OF THE "MINI-SCOPE"
(prepared by Robert Morecock)

The "Mini-Scope" is a small children's microscope. It is the product of the mind of William Gilmore Smith, educator and inventor. It was developed over a ten-year period of planning and experimenting, both in the classroom and in the workshop. The Miniscope was designed to fill the need for an inexpensive yet effective tool for the elementary school child who is using the basic scientific techniques in investigating his world.

Production of the Miniscope was initiated in the CCSS Project during the summer of 1966 at Montgomery Junior College, Rockville, Maryland. In this program 150 Miniscopes were planned for assembly by the participating elementary school teachers.

In procuring materials for 150 Miniscopes, the 22 individual parts had to be purchased in retail quantities. This caused the cost of the Miniscope to be higher than anticipated. Wholesale buying enabled us to consider further large scale production. For economy and educational value, familiar and commonly-available parts are used in the Miniscope such as Christmas tree bulb hangers for stage clips, a thread spool for focusing knob and other small parts.

Another item of concern was the fabrication of the wooden parts ready for assembly. Blueprints and lumber had to be modified because of cost, availability and recent laboratory experiences. Mr. Allan D. Brown, Industrial Arts instructor at Earle B. Wood Junior High School, consulted with the inventor, W. G. Smith, to develop production techniques.

After evaluating the pilot project, it was decided to proceed with the production of 3000 Miniscopes, which would be distributed to schools in the Washington metropolitan area.

One of the most critical matters was that of obtaining the proper types of lenses. The inventor had succeeded in securing two lenses of satisfactory quality from the General Electric Company in Cleveland, Ohio, in the last few years. Difficulty in obtaining the two sizes of lenses from G. E. remained a problem, however, because of several factors. When the lenses could be supplied, they had to be purchased in lots of 10,000 to make their cost reasonably within the limits of the Miniscope production budget.

As the Miniscope was distributed, the demand increased as it cost only 75¢ each compared with around $3.00 for the

commercial product and it worked just as well.

By the conclusion of the project we had made over 5,000 for eight school systems, and the project was written up in the Sunday Star Magazine on January 8, 1967.

Number of Miniscopes Produced and Their Distribution

Frederick County	144
Baltimore County	1000
Montgomery County	1443
Prince George's County	1253
Arlington County	636
Alexandria City	60
Fairfax County	16
District of Columbia	16
Parochial	493
Private Schools	52
Miscellaneous (an estimate)	430
TOTAL	5543

Results

The majority of teacher-participants evaluated the emphasis on inquiry as successful and valuable, especially in providing them with the opportunity to practice behavior they will require of their own students. A few felt insecure in the unstructured situation a laboratory organized for inquiry presents.[2]

The microscope project that developed out of the program enabled many teachers to teach the Small Things Unit in schools where budgets did not allow purchase of the commercial version. Our "homemade" product was felt to be superior as the children were able to assemble the instrument themselves.

Twenty teachers attended at least five of the six Saturday meetings during the academic year. An additional twenty attended an average of three seminars each.

At the end of the academic year ninety questionnaires were sent out. Almost all of the one-third returned were from Montgomery and Prince George's Counties. About one-half of their teachers responded.

The questionnaires provided further data that may be used in evaluating outcomes of teaching ESS Units. Three outcomes ranked most important were increased observational ability, open-mindedness and self-confidence.[3]

Teachers also identified factors that detract from achieving these results with working conditions being first.

The final evaluation of the program by teachers was very favorable and representative quotations are included in appendix D.

The inquiry-oriented curriculum requires greater support of teachers in two areas. The first is in-service programs where teachers on school time may obtain training in inquiry techniques and necessary content background. The second area is sufficient science equipment and supplies - especially readily accessible living materials - to conduct classes.

A third problem area is evaluation of inquiry instruction. Standard tests are generally recognized as being unsuitable

[2] Refer to Appendix B
[3] Refer to Appendix D-1

and other forms must be developed. The lack of sufficient evaluation instruments is a source of great frustration to teachers - especially if they are required to grade on an A-F scale in elementary schools. Part of the solution to this problem area must involve the teacher more actively in the role of evaluation.

School systems are optimistic about implementing new and improved science materials reflecting the "inquiry approach." The degree to which this is successful is related to the extent a school system can deal meaningfully with these problems.

The conduct of the year-program described in this report may serve as a model in the area of in-service training.

Cooperative College-School Science Project

Montgomery Junior College

Rockville, Maryland

20850

List of teachers completing the Science Seminar for Elementary Teachers June 27 - July 15, 1966.

VIRGINIA SCHOOLS

Alexandria City Public Schools

Mrs. Barbara Adgate

Miss Carolyn K. Adkins

Miss Joan Blankenship

Miss Edith Burton

Miss Elizabeth Fordham

Arlington County Public Schools

Miss Lyona Ackerson

Miss Mildred C. Black

Mrs. Lillian Brent

Mrs. Ruth-Lois Bryson

Mrs. Betty P. Constantz

Miss Mary Elizabeth DiSalvo

Mrs. Aimee Dye

Mr. Hunter E. Fortney

Mrs. Katharine Gibson

Mrs. Lucille S. Goodman

Miss Karen Ann Haak

Miss Helen W. Martina

Mrs. Charlsie B. Tarantola

Miss Grace Thada

Miss Beatrice Welton

MARYLAND SCHOOLS

Frederick County Public Schools

Mrs. Ella Bell Fraser

Mrs. Nancy Hendricks

Mr. Thomas Sterling

Mrs. Nancy Virts

Montgomery County Public Schools

Mrs. Ethel Anders
Mrs. Therese Arntz
Mrs. Elizabeth Baer
Mrs. Jane Barton
Mr. Stephen Bedi
Miss Lavina Bierer
Mr. Donald Boger
Miss Alvia Rose Cook
Mrs. Kethleen Dennis
Miss Maria Diaz
Mr. Donald Dunlap
Mr. James Edwards
Mr. Victor Exner
Mrs. Nannie Fleming
Miss Katherine Foti
Mr. Henry Gardner Jr.
Mrs. Faith Goldstein
Mrs. Pheebe Goodwin
Mrs. Helen Goundry
Mrs. Bertha Hauenstein
Mrs. Eloise Hauver
Miss JoAnne H ogan
Mr. Jesse Horsman
Mr. Wilfred Huskonen
Mrs. Ethel Jones
Mr. Michael Kanter
Mrs. Frances Kastenbein
Mrs. Nancy Kneece
Miss Mary Lou Kollmer
Miss Rosalind Lawshe
Mrs. Rebecca May
Mr. James L. Mills
Miss Gladys Morris
Mrs. Martha Ogles
Mr. William Peacock
Mrs. Margaret Ragland
Mrs. Barbara Reese
Mr. Jefferson L. Roberts
Mr. Robert J. Shekletski
Mrs. Barbara Simmons
Miss Phyllis Smith
Mrs. Mabel Wright

Prince George's County Public Schools

Mr. Bruce Ambrose
Mr. George Austin
Mr. Robert Bertl
Mrs. Elizabeth Burslem
Mr. William Collins
Mrs. Barbara Conley
Mr. Arthur Dock
Mr. Gerald Fondessy
Mrs. Karen Fondessy
Mrs. Margaret Harmon
Mr. Carl Hoffman
Mr. John Landi
Mrs. Ethel Lewis
Mrs. Frances Lowell
Mr. Jack Pevenstein
Mr. Anthony Randolph
Mrs. Ann Tobias
Mrs. Judith Westerman
Mrs. Elsie Wild
Mr. William Yates

PRIVATE SCHOOL SYSTEMS AND THE DISTRICT OF COLUMBIA

Private

Mrs. Irene Ansher, Town and Country School, Wheaton, Maryland

Mother John Bosco, R.J.M., St. Mark's School, Hyattsville, Maryland

Miss Berenice Brezzaro, Blessed Sacrament School, Washington, D.C.

District of Columbia Public Schools

Mrs. Gladys Bellows
Mrs. Jacqueline Burton
Mrs. Helen Colton
Mr. Don Larsen
Mrs. Alice McNeil

Robert B Nicodemus

Robert B. Nicodemus
Director, CCSS Project
Montgomery Junior College

William M. Benson

William M. Benson
Registrar
Montgomery Junior College

TEACHER EVALUATIONS OF SUMMER PROGRAM - July 1966

1. Will you be trying anything different in your classroom as a result of this experience?

Yes	55
Maybe	2
No	0

Some representative answers were:

"The atmosphere of "inquiry" will be mine as well as my students."

"My attitude will certainly be one of enthusiasm, and I'm hoping that at least this much will be an impetus to get the students in a mood for wonderful "discoveries"."

"I was highly impressed with the use of graphs to show partial outcomes."

"This has been one more reminder that we teachers do too much talking and not enough involving of the children in the learning process."

"I will encourage observation more, allow more freedom for student hypothesis by delaying conclusions."

"My Science corner will be the most important spot in the classroom."

"I'll decrease the amount of "lecture" teaching, allow more time for experimentation."

"I have seen and felt the thrill of discovery and will try to give my children the same advantage."

"Without the pressure of memorizing facts, I am sure the children will learn more."

"Prior to the workshop I would have felt hestitant teaching any phase of physics. Now I would like doing some units in this field."

"I will be more secure in working with children and therefore quicker to take advantage of the opportunities that occur within the environment to encourage inquiry."

"I hope to use optics with geometry. I have much more respect

for the metric system and will use direct measurements regularly."

"The idea of having students work in groups, compile and compare data and formulate their own hypothesis is excellent."

"I will place resource material, namely books, within reach of the children. It's fine for college professors to hand out bibliographies, but it would have been finer if a few of these highly recommended books had been available in the classroom."

2. <u>Should the program have been more structured or less structured?</u>

Just right	35
More structured	32
Less structured	3
No opinion	6

<u>Specific comments from "just right" group were:</u>

"I think alot of teachers who want it to be more structured are simply misunderstanding the whole thing."

"Learning is more comfortable in a casual situation such as this."

"Very comfortable and relaxed atmosphere. Teachers enthusiasm contagious."

"I feel working at own rate was most beneficial."

"It was structured enough so that we knew where we were going, yet not so structured to rule out individual experimenting according to interest. Where interest is high, learning will be present."

"Very impressed with the set-up. Design of workshop and its implementation first rate."

<u>Among the reasons given for making the workshop more structured were:</u>

"To get the basic facts. Some things can't be learned just from observation."

"I'd like having a written outline or skeleton upon which to build. It helps in remembering later, too."

"We tend to get lazy if not told exactly what to do."

"I think the basic philosophy of the program should be clearer from the start so teachers can profit more from their experiences rather than wonder what it's all about."

"Methods of approaches should be defintely spelled out for better understanding."

"It's fun to discover and learn, but there is not time for a teacher to do so. She should have as much knowledge as possible in order to guide students into discoveries they make."

Those preferring less structured workshops gave these reasons:

"I think exchange of ideas is more important than the content."

"Let students proceed largely at own rate. If we are to use this method in teaching, then we ought to use this method in learning."

3. What constructive criticism can you offer?

Sessions too long	15
Need worksheets, simple drawings or pictures	9
Need air conditioning	9
Too much eye strain	7
Too much repetition	6
Need more interchange of ideas between teachers	5

Specific remarks were:

"Need a definite statement of what results should be."

"Need a little more group planning before starting session and a summary afterward."

"Give us chance to find our own specimens."

"Suggestion on grading would be valuable."

"Need suggestions on how to work with large classes; i.e., 40 pupils."

"Would like to see children in workshop in order to observe their problems, behavior, etc."

Other Comments on Seminar

"This seminar has so stimulated my curiosity that I feel my students shall not be able any more than I was to fail to "catch" a deep appreciation and curiosity about what surrounds us in such multiplicity."

"Being free from 'pressured memorization of facts' and actively engaging in the use of apparatus unfamiliar to me was a challenge."

"This seminar provided teachers an opportunity to interact with representatives from school systems in the area."

"An excellent over-all workshop."

"A great boon to teachers in their efforts to lead pupils to a self-directed learning process that can go with them through life."

"Many children should have a happy experience in Science classes as a result of this Science Seminar."

"In spite of the extreme differences of the participants, the program was able to emphasize the appreciation and development of individuals."

"It was very stimulating to be taught by dedicated people who possess the remarkable ability of imparting both knowledge and enthusiam for their subject."

"My reaction to the seminar can be likened to a child's first successful focus with his miniscope. It opened a whole new world of ideas."

"I had always envisioned science as a separate world of specialists because I had no scientific training. This seminar opened the door to a fascinating, welcoming world."

"Any gathering of teachers of the same level on any given subject is beneficial. This gathering was enhanced by our group's "play the game" spirit and the splendid grouping of MJC instructors."

"The lectures made me aware of how little I know about many subjects in the scientific field. The afternoon sessions gave me new ideas on how to make more appealing -- and, I hope, more profitable -- to grade-school children."

"I am looking forward to sharing with my children the fun, thrill

and limitless possibilities of science."

If similar programs were maintained periodically in science and other areas, there would be long range benefits in better equipping the much-harassed, over-worked, bitterly-critized classroom teacher to do a better job and more thoroughly satisfy our professional level people that they can do an adequate job given the right background tools and environment."

"The seminar has made people stop to think about their teaching ... and this pause for thought seems to be resulting in new ideas of teaching, which hopefully will improve students' knowledge of science."

"The challenge to teach better science in the elementary grades has been given by capable instructors -- an enriching experience."

"The respect and patience the faculty showed each teacher when answering the questions was admirable."

"I came, tongue in cheek, after experiences in other workshops and stayed to be delighted."

"Whenever teachers are encouraged to examine their own methods and are exposed to new and better ways, the ultimate result is better teaching."

"This course has forced teachers to "do it themselves". Adverse comments seemed to stem from old concepts that there is "a right way."

"The seminar has made me so dissatisfied with both my background knowledge and my approach to teaching science that I plan to really work on them."

Letter Sent to Teachers of "Small Things"

Since the commercial edition of the "Small Things" Teacher's Guide will not be available until after November 1, 1966, we are providing the comments below so you may begin the unit. You should at this time begin growing onion root tips by placing the bottom of onion bulbs in shallow water.

Some of the objectives of the unit are discussed in the following quotations from the experimental edition.

> "to provide the child with a valuable instrument which extends his senses in a radical manner - to lead him in using this instrument to see for himself a much smaller level of organization of living and sometimes nonliving matter than can be seen with the unaided eye."

> "the work is planned in such a way that the child can discover for himself whether the divisions he sees in an onion skin are found in everything - or just in living things. He should investigate for himself before he is told; make good and poor comparisons before they are made for him."

> " you should try to tolerate uncertainty, tentative answers on big issues ... at the same time you can continually be encouraging accuracy, precision in description and observation, and refinement of other detail wherever possible."

> "Many times one can ask the child, 'How could we find out?'. This question can lead to some very fruitful explorations."

> "It is important that the children should not feel rushed and that they should have a chance to try experiments which occur to them as they work, but which we have not specified." Average total class-time in the experimental edition was 35 - 45 hours over a period of 2 - 3 months.

> "The use of a hand lens can go along with your general introduction of the unit. A very natural question will emerge, whether one can magnify still more, and the word microscope will come from many or most children."

Some of the kinds of questions that may be asked in class are:

How can we see more of something? After describing an object

you may have a game to see what else can be said about it with the help of a lens.

How large is it? This question should be frequently repeated. Even the repeated use of an arbitrary unit such as ahair width will encourage the habit of thinking or describing quantitatively.

How much can we see? Look at printed page with hand lens. Draw circle around lens on paper. Now look through lens, holding it away from the paper so it magnifies. Now draw a circle around what you can see. What is the change in diameter of circle. This is directly related to magnification. Discuss idea of field of view.

After microscopes are completed, repeat above. Prepare wet mounts using small cut squares of thin plastic included in your kits. Measure air bubbles. Nylon fabric may provide a grid pattern which assists estimates.

Examine onion skin from inside of leaf. Emphasize observation of a number of specimens. What is typical? How do they compare? Are they fatter or longer? How much? Use stains to see more.

Prepare slide of a cell from inside the cheek. Are animal surface cells different from plant surface (inside surface) ones?

Are all the cells of a plant the same? (You should have spent a few days total on activities growing out of the questions above. Develop ideas and questions fully. Do not rush) Examine cells from all parts of the onion bulb. Look at cells from roots and leaves and from the parts of many common vegetables. Have children bring some in. Question intensively how they are different. Establish standard comparisons and make large charts for everyone to see. Duckweed root tips are good. Stress measurement. How much longer than wider? Spend a couple of weeks developing this aspect of comparison. In fact, spend as long as you think it is productive and meaningful.

Obtain stagnant water or pond water (the greener it is the better). Trap organisms with cotton fibers or slow them down with methyl cellulose (included in kit). Describe the creatures seen, their size, shape, color movement, insides, etc. How do they compare with plants cells (protozoa).

Hopefully, by this time you will have received the Teacher's Guide which may be somewhat revised from the comments above and the experience you had this summer. Sorry for the delays but they were out of our control.

Robert B. Nicodemus
Director, CCSS Project

Follow-Up of Teachers - June 1967

1. Number of questionnaires sent out 90
   received 30

2. Number of teachers that have read ESS units

   Small Things 20
   Kitchen Physics 22
   Mealworms 21

3. Number teaching ESS units

   Small Things 18
   Kitchen Physics 10
   Mealworms 4

4. Reasons given why ESS units were not taught

   Lack of funds or materials ... 8
   Not in curriculum 7
   Lack of time 7

5. Outcomes of ESS units that teachers list as important or desirable - in order of frequency mentioned

   The students

   - ask better questions, more observant in making comparisons
   - have a more open mind to many possible answers and share answers in group activities
   - have more self confidence, reliance on their own observations, work independently
   - are stimulated to find out more about their world, have more liking for science
   - have an increased capacity to organize data
   - use their own language and methods, establish their own objectives and are actively doing

6. Factors detracting from achieving above outcomes - in order of frequency mentioned

   - working conditions - lack of materials, short periods, inflexible scheduling
   - children that do not work well in an unstructured situation
   - tendency for teacher to exert too much control, inability to permit failure, lack of patience
   - classes too large

7. Specific quotations from teachers on program

   "The Small Things Unit was, I believe, more important in the

actual learning of "factual" material. It also opened a new world to the children. The Kitchen Physics, on the other hand, was more valuable in a way because it taught children to question their data and those of other children and to evaluate this data in as precise a form as warranted."

"The afternoon sessions were of great benefit simply because I was able to experience what the children in my class were to be taught."

"(1) It made me very conscious of not giving or teaching concepts, but let the children determine for himself. (2) It helped me in motivating the child to keep records of what was observed. (3) It helped me to encourage the child to always share his findings and to expect differences and to look for these."

"I incorporated techniques learned during the summer with my school program."

"The instructor's emphasis on not giving answers and permitting students to come to conclusions through analysis of their own data was helpful in approaching these units in the classroom."

"The 1966 summer program was excellent, and it was a great help to me."

"The laboratory experiences were challenging and gave me confidence to try new experiments in the class. The individual miniscopes were used enthusiastically by my class."

"The experience of the summer program was far superior to any lecture science course."

"The summer program was excellent in kitchen physics. This meant the difference between a creative enthusiastic approach and a more-or-less text book approach to an area with which the writer was unfamiliar. I'm certain we'd not have had as much fun with it nor have devoted the almost daily 45-minute sessions to it which we did. Most of the children tried additional experiments at home."

"The monthly Saturday sessions were EXCELLENT and practical for personal and classroom use. Could these be continued?"

"The objectives and methods presented this summer were valuable, I felt, in many phases of teaching and certainly in teaching any science unit."

"Gave experiences with units prior to teaching them which opened the way for me to try something new. Without such help, I probably would not have tried."

"Helped break down my search for and expectation of finding the

one right answer. I could then be more accepting and help children to be more accepting of a variety of answers."

"Made science less fearful - more fun."

"Provided materials - ESS booklets and notes to look back on."

"Opened a new resource - the Junior College itself. Found hel as near as the telephone."

"A most effective program that accomplished more for me than I sure it was designed to do."

List of teachers satisfactorily completing the Science Seminar for Elementary School Teachers October 1966 - March 1967

Alexandria City Public Schools

Miss Elizabeth Fordham

Arlington County Public Schools

Miss Lyona Ackerson
Mrs. Katharine Gibson
Mrs. Charlsie Tarantola
Miss Beatrice Welton

Montgomery County Public Schools

Mrs. Therese Arntz
Miss Lavina Bierer
Mr. Donald Boger
Miss Katherine Foti
Mrs. Phoebe Goodwin
Mr. Jesse Horsman
Miss Rosalind Lawshe
Miss Gladys Morris
Mr. William Peacock
Mrs. Mabel Wright

Prince George's County Public Schools

Mr. Bruce Ambrose
Mr. Gerald Fondessy
Mrs. Karen Fondessy
Mrs. Frances Lowell
Mr. William Yates

ESS Planning Session 1

The first planning session for the Science Seminar for Elementary School Teachers was held March 9, at Montgomery Junior College. The public schools of Montgomery, Prince George's and Arlington County were represented.

Mary Lela Sherburne, consultant for Educational Services Incorporated, gave a brief history of Elementary Science Study materials. The group then worked with "the cocktail shaker" by which a basic philosophy of E.S.I. was demonstrated. The ESS materials deal with things that the child can demonstrate to himself. Perhaps the fundamental skill which a teacher must possess is the art of questioning. When a child asks "Why does this happen?" it is the teacher's responsibility to help the child break that question down into small enough parts that can be answered by "direct evidence." "Why" is a very difficult question to answer and in response to it the teacher does not say "Why do you think?" but may say "What is happening that you do not understand" or "Tell me what you do see happening." When the teacher attempts to answer the "why" questions of a child, there are two dangerous assumptions that lead to a breakdown in communication. The first is the assumption that the teacher knows what the child has observed and the second is the child's assumption that the answer sought can be shown or demonstrated.

ESS Planning Session 2

Notes from the second planning meeting for the Science Seminar. Public schools of Arlington, Montgomery and Prince George's County represented. Mary Lela Sherburne conducted the meeting. March 14, 1966

Small Things unit was introduced. The hand lens was distributed and we were asked: How many ways can you make things bigger? How do you know it's bigger? How much bigger is it? What is the relation between the distance from the eye to the lens to the object? Can you make a water lens?

(Note: these sessions are conducted in an inquiry method, in the way that elementary teachers might conduct their own classes. For example, the questions above are very general. Children will work on these problems intensively when the directions are not too specific. If the teacher shows the "right way" to proceed, the children's interest is short lived and their exploration limited.)

Next, we worked with the AS&E microscope. Caution: Never get light directly from the sun. What do the wheels on each end do? How do you get more light looking through the hole? Put some things on the slide. What can you see? When you put water under a smaller slide (coverslip) can you find an air bubble?

(Note: if you try and tell children how to do everying at first they will not listen. They have to encounter the problem and get answers in small amounts.)

Next, we looked at a twenty-five minute film of children working with the AS&E microscope. They compared the appearance of different materials such as salt, sugar and cornstarch. The children learn from each other as they encounter more difficult problems.

(Note: drawing provides a good feed-back and enables the teacher to get an idea of what the child is doing and seeing -- a form of non-verbal communication especially good for children with reading problems. But it is important not to tell them to draw. They will do so more readily by subtle suggestions. "John, come up to the board and draw what you see." Then John's observation is appropriately labeled e.g. "John's amoeba." Very quickly the teacher will find students anxious to draw their observations and they will begin to do so when paper is available.)

ESS Planning Session 3

Notes from the third planning session held Monday, March 21, 1966. Conducted by Mary Lela Sherburne.

For the most effective summer seminar let teachers learn in the way that they will want their children to learn. We are covering in a few meetings what must be developed over many more hours of activities. This material must not be rushed this summer. For example, the work with onion cells should probably last three weeks (with two to three hour sessions per week. Small Things usually goes for ten weeks or thirty hours.)

Staff conducting the seminar this summer should spend the next three months observing elementary classes (Small Things or Kitchen Physics) and where possible questioning children about what they see or think. Teachers should not try to get the child to say what they (the teacher) wish. To interact in a meaningful way with teachers this summer, the staff must become familiar with patterns of learning in children. The method of the ESS material is to involve the child in a situation so they cannot help but learn and develop habits for more effective learning. In addition to observation of classes, you should read some of Piaget's work.

How large were the onion cells we looked at last week?

"about that big" (holding fingers apart)
"about as big as a pin head"
"a little longer than the width of a hair"

How can you find out if your onion cell is the same size as someone elses?

(develop idea of value of relative measure, such as hair width for quantitative comparison)

Were all the onion cells the same size and shape?

"were not uniform"
"elongated and irregular"
"more round than square"

Could you draw one?

(continually push the students back to make them realize they haven't seen very well by asking for information based on what they see)

Let's make some more slides to see if the drawing looks like the actual cells. There are some stains you may use to help you see more.

(Again, do not show them a technique for staining. Let them work it out for themselves. This way will be more messy, noisy and time consuming but it will encourage independent investigation and utilize their innate desire to explore. Ask questions of size, relative size, shape, variation, etc.)

"mine was three times as big as hers"

Where do big ones come from? How do cells from different parts compare?

(Many will realize they haven't noticed from what part they obtained their cells. Record observations on board to serve as a basis for discussion and to encourage the children to record their own data.)

Next we will compare how large some freshwater animals are compared to plants.

(Often, more meaningful discussions come at the beginning of the next class period as it is difficult to get them settled down from this kind of work."

ESS Planning Session 4

Summary of Workshop on "Kitchen Physics" conducted by Dr. Malcomb Skolnick and Mr. John Bigelow of ESS. Conducted March 31, 1966, at Montgomery Junior College, Takoma Park, Maryland

Comments by Skolnick:

Work on "Kitchen Physics" began four years ago as an interest in the properties of liquids. Emphasis developed on experimentation and observation rather than vocabulary and concepts. A simple medicine dropper has many uses. Are the drops always the same size? Why not? How would you tell?

Responses:

"weigh drops" "take slow motion"

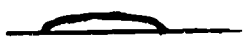
(waxed paper, droppers, paper cups are handed out)
Why don't you try to make size of drops different?

"dropper held sideways takes 83 drops to make 5 cc."

"held vertically takes 100 drops to make 5 cc."

Can you change the water drop more?
(solution of detergent and water handed out)

"water drop on waxed paper looks like  "

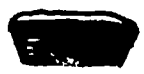
"and detergent drops look bigger and flatter  "

What do you mean by bigger?

"diameter" "spreads out bigger on paper towel"

Can you judge volume by diameter? What do you want to look at and take for "size"? What other differences did you notice?

"water over-fills a cup  but

"soapy water runs over sooner  "

What would oil look like?

"depends on viscosity"

What is viscosity?
Why do you think water "heaps up" more or makes rounder drops?
"molecules hold together more"
"thicker it is, the rounder it is"

You will find many of these same points come up with children. Some focus on shape or "heaping" characteristics, or race of drops down an incline and they worry about the internal forces which change drops.

Now close your eyes and tell me what I am doing. (Class guesses)

[illegible] pouring from bottle into pan of water makes a splattering sound. (same bottle held some distance away)

Now close your eyes again and tell me what I am doing. (There is no noise)

Now look.

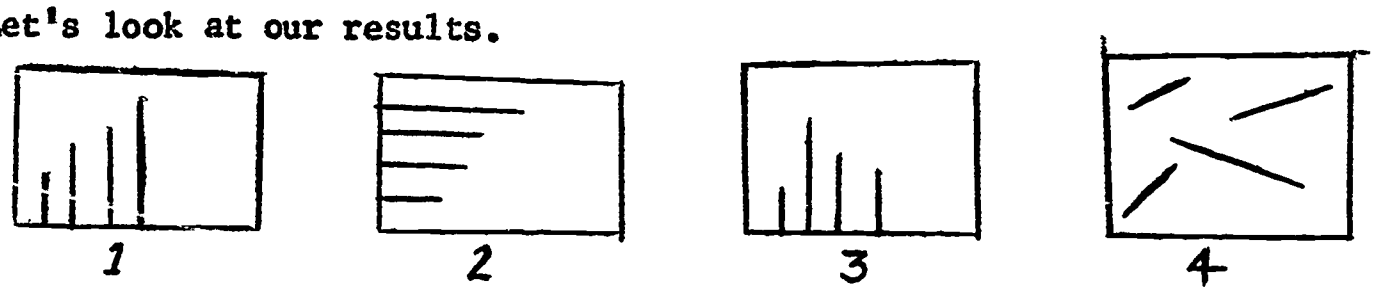
(Pouring water again but bottle is closer to pan, making no splattering sound)

Why do you say it is "breaking off into drops"? How will the size of the hole effect it?

"measure length of smooth stream to where it becomes rough"

(One group measures by sound. Groups keep record by cutting construction paper to length of smooth water column and pasting on sheet)

Let's look at our results.



Notice Number 4 (by Skolnick). You will find that children do not arrange graphically. I do not recommend that you tell them how to do it or even to do it. They should arrive at more meaningful arrangements by the questions you ask. Here is a new strip. Where does it go? (Referring to charts 1 through 4). It doesn't make any difference with #4. How about #1? Why do you want to put it there?

"there is a pattern"

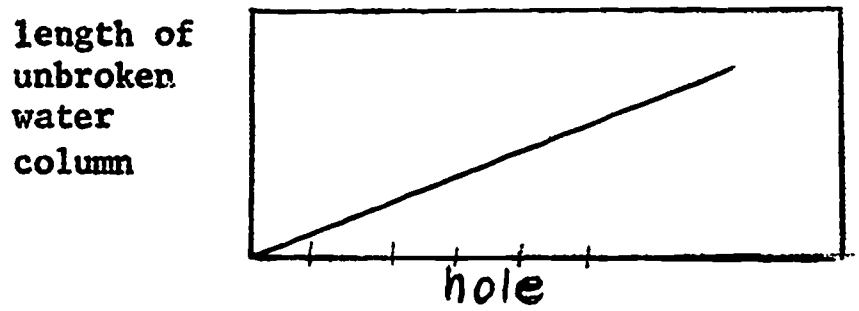
What can you tell me about the size of the hole by this new strip?

"larger than the second, smaller than the third"

Here is another strip (much longer than any other). Where should it go? Why do you want it there? Through such questioning you will get them to use linearity and graphical relation to arrange data in a more meaningful way.

There is always such a range of ability that you want to draw out the experiences and discussion enough to make sure they are with you. It is not necessary to introduce specialized terminology or get into other complexities. The laminar flow of a liquid is almost a linear relation to the diameter of the hole -- within limits. You can extrapolate too far. Description of water column gets into concepts such as viscosity, surface tension, cohesion, geometric properties, range and propegation of interaction between molecules.

What is another way we can draw this graph?



Where would soapy water be on it? Draw line you predict. Why does the column pinch off and make a drop? Why doesn't it start off in drops?

"parts go faster"

Idea of gravitational acceleration important.

"may be column gets skinnier"

Why?

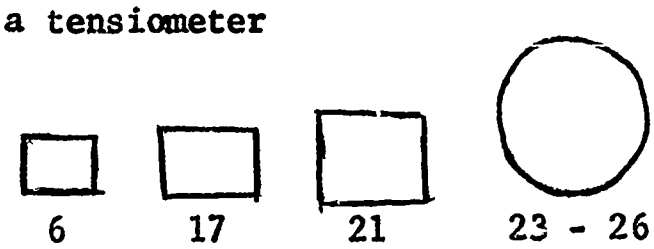
"runs out faster?"

Which runs out faster? (use metronome rather than clock as many cannot read clock accurately and counting clicks frees eyes for observation).

Hole	1	2	3	4	5
Water	20	29	56	133	
Soapy water	20	31	56	131	
Oil	214	38	76		
Karo syrup	220	410			

When values from different students are taken, begin to emphasize concepts of "error." Go back and have students analyze conditions under which experiment was conducted. Point out the number of variables not controlled.

How else can you measure affinity of fluids to itself and other objects? How much is it attracted to surfaces? How strongly does it hold on to paper? What do you mean by strong? We can obtain more quantitative evidence by use of a tensiometer



Water	6	17	21	23 - 26	number of weights required to pull surfaces apart
Soapy water	3	9	17	16	

What position was the arm in? Do you get some results when arm of balance is always horizontal?

In the above summary by Robert Nicodemus, not all of the responses from the class were recorded. I was most interested in analyzing the technique Skolnick used in presenting the material. He was careful to avoid communicating (verbally or non-verbally) whether your response was right or wrong. His response was non-specific "what an interesting answer" or "I'm still wondering, questioning." He gives no clue as to how he wants the child to answer. (The "right" answer is what the child observes). He continually asks questions to draw out the experience relying on what is observed and not by reward of the "correct response."

Skolnick has done a slow motion 8mm. film loop of beading of a water column which would be a valuable follow-up to completion of this unit. Seeing water column actually break off will dispell any doubts of the students as to the reality of the event.

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