R E P O R T R E S U M E S

ED 012 235 SE 000 068

REVIEW OF RESEARCH STUDIES IN SCIENCE EDUCATION.
BY- TAYLOR, WAYNE AND OTHERS
MICHIGAN ST. UNIV., EAST LANSING

PUB DATE 66

EDRS PRICE MF-$0.09 HC-$2.04 51P.

DESCRIPTORS- *BIBLIOGRAPHIES, *EDUCATIONAL RESEARCH, *SCIENCE EDUCATION, *SECONDARY SCHOOL SCIENCE, ATTITUDES, ACADEMIC ACHIEVEMENT, BIOLOGY, CURRICULUM, CHEMISTRY, EVALUATION, EFFECTIVE TEACHING, EARTH SCIENCE, GENERAL SCIENCE, INSTRUCTION, INSERVICE EDUCATION, INSTRUCTIONAL MATERIALS, LEARNING, PHYSICAL SCIENCES, PHYSICS, SCIENCE FACILITIES, TEACHING METHODS, TEACHER EDUCATION, *RESEARCH REVIEWS (PUBLICATIONS), EAST LANSING

SECONDARY SCHOOL SCIENCE EDUCATION RESEARCH STUDIES CONDUCTED DURING 1963-65 ARE REVIEWED AND COMPARED WITH THOSE REVIEWED DURING 1961-63. TITLES OF 195 RESEARCH REPORTS WERE OBTAINED FROM PERIODICALS, SERIAL AND NONSERIAL BULLETINS, AND INDEXES. ABSTRACTS OF 125 DOCUMENTS WERE OBTAINED AND REVIEWED BY A COMMITTEE. THE STUDIES WERE CLASSIFIED AS (1) SURVEY AND STATUS, (2) ANALYTICAL AND SURVEY, (3) EXPERIMENTAL, OR (4) CURRICULUM. DURING THE 2-YEAR PERIOD THE NUMBER OF SURVEY AND STATUS AND CURRICULUM STUDIES INCREASED WHILE THE NUMBER OF ANALYTICAL SURVEY AND EXPERIMENTAL STUDIES DECREASED. REVIEWS INCLUDE A SHORT DESCRIPTION OF THE STUDY AND RESULTS OBTAINED. A BIBLIOGRAPHY OF THE STUDIES INCLUDED IN THE REVIEW IS PRESENTED. (AG)

REVIEW OF RESEARCH STUDIES IN SCIENCE EDUCATION

Secondary School Level Committee* 1961 - 63

Science and Mathematics Teaching Center
Michigan State University

Members of the staff of the Science and Mathematics Teaching Center at Michigan State University, as a cooperative service with the United States Office of Health, Education, and Welfare and the National Association for Research in Science Teaching, assumed the responsibility for the review of research in secondary school science for the 1963-65 biennium. It has been an interesting and challenging activity, and we trust that our compilation and analysis may be useful to the science education community.

Review of Sources of Science Education Research

Fifty-seven periodicals, one serial and one non-serial bulletin, and three index sources (Appendix A) were systematically searched to obtain the titles, names, and the addresses of the authors of published research. One hundred and ninety-five titles (Appendix B) resulted from this literature search. The titles were transmitted to Dr. Lloyd Johnson of the U.S.O.E. staff for his use in securing abstracts of the studies. From these and other sources, Dr. Johnson forwarded to the committee one hundred and twenty-five abstracts for review.

Review of Abstracts

Table I summarizes the categories and final disposition of the studies received. By agreement of the committee under the chairmanship of Dr. Lloyd Johnson, categories of previous biennial surveys were replaced by a classification system recommended by Novak[1]. The committee recognizes that the grouping used in this report is somewhat arbitrary and that other reviewers might have arrived at different categorizations. The subsets intersect particularly between "Survey and Status" and "Analytic Survey," and many of the "Experimental" and "Curriculum" studies might well fall into both categories.

----

*Members of the committee: Julian R. Brandou, Frederic B. Dutton, John M. Mason, Clarence H. Nelson, William J. Walsh.
Chairman - Wayne Taylor

[1]Novak, Joseph D., "A Preliminary Statement on Research in Science Education," Journal of Research in Science Teaching, Vol. 1, pp. 3 - 9 (1963).

TABLE I

CATEGORIES OF

ABSTRACTS RECEIVED

CLASSIFICATION	REPORTED	LISTED	TOTAL
SURVEY & STATUS	19	18	37
ANALYTIC SURVEY	18	5	23
EXPERIMENTAL	7	11	18
CURRICULUM	13	34	47
TOTAL	57	68	125

Sources of Studies

Abstracts of sixty-three doctoral and twenty-nine masters' theses were received by the committee. In addition, thirty-three miscellaneous abstracts were received. The committee disposition of the studies is shown in Table II.

Each of the one hundred and twenty-five abstracts was independently reviewed by three members of the committee and the committee chairman. Basic criteria for inclusion in the final report were the suggestions included in the committee manual[2] and in Novak's article[3]. It should be noted that the determinations were made from the abstracts submitted, and the committee fully recognizes the limitations involved in not working from the original study. There were, not unexpectedly, differences of opinion on some of the studies. In these cases a majority opinion was used as the basis for the final decision. Every effort was made to produce consistent and unbiased reports. A bibliography of the abstracts of the studies examined is shown as Appendix C.

General Comments on the Abstracts Submitted

Unfortunately time and personnel limitations prevented the committee from reading all the original studies, and our comments must necessarily be interpreted as stemming from the abstracts themselves. Many of the abstracts were poorly prepared; as a result, the reviewers feel that many of the studies may appear to lack lucidity, direction, and purpose.

---

[2] Obourn, Ellsworth S., Martin, W. Edgar, Blackwood, Paul E., and Johnson, Lloyd K., "Manual for Collection and Evaluation of Research in Science Education." Ditto, U. S. Office of Education, September, 1963.

[3] Op. cit.

Serious questions might be raised about some of the research designs. Since 92, or 74 per cent, of the studies were masters' and doctors' theses, it seems appropriate to point out that better supervision of the research design and reporting should be a more active responsibility of the major professors involved.

TABLE II

SOURCES OF ABSTRACTS RECEIVED

	Doctoral			Master's			Misc.			Total		
	R[1]	B[2]	T[3]	R	B	T	R	B	T	R	B	T
Survey and Status	10	5	15	1	7	8	8	6	14	19	18	37
Analytical Survey	14	3	17	0	1	1	4	1	5	18	5	23
Experimental	6	7	13	0	0	0	1	4	5	7	11	18
Curriculum	12	6	18	0	20	20	1	8	9	13	34	47
TOTAL	42	21	63	1	28	29	14	19	33	57	68	125

[1] Recommended for Abstract Inclusion by Secondary Level Committee.

[2] Recommended for Bibliography Inclusion by Secondary Level Committee.

[3] Total R + B.

The use of questionnaires and, to some degree, jury techniques, again seem to predominate, particularly in the survey and status and analytic survey classifications. Serious questions might be raised about the depth of many of the studies and about the validity of instruments used. There certainly is little indication that concentrated attention has been given to the nine categories of issues and problems discussed at the 1960 and following meetings of the National Association for Research in Science Teaching. In our report two years ago we postulated that studies for this biennium might begin to reflect this emphasis, but the change is not apparent.

There was, however, an interesting shift in emphasis as well as committee assessment of quality. The data are shown in Table III.

Table III. Comparison of 1961-63 and 1963-65 Studies
by Category and Committee Recommendation

			Doctoral			Masters			Miscellaneous			Grand Total		
			R	B	T	R	B	T	R	B	T	R	B	T
I. Survey and Status	1961-63	Number	6	9	15	0	7	7	3	15	18	9	31	40
		Per Cent	3.6	5.3	8.9	--	4.1	4.1	1.8	8.9	10.7	5.3	18.4	23.7
	1963-65	Number	10	5	15	1	7	8	8	6	14	19	18	37
		Per Cent	8.0	4.0	12.0	.8	5.6	6.4	6.4	4.8	11.2	15.2	14.4	29.6
II. Analytic Survey	1961-63	Number	18	6	24	2	4	6	7	2	9	27	12	39
		Per Cent	10.7	3.6	14.2	1.2	2.4	3.6	4.1	1.2	5.3	16.0	7.1	23.1
	1963-65	Number	14	3	17	0	1	1	4	1	5	18	5	23
		Per Cent	11.2	2.4	13.6	--	0.8	0.8	3.2	0.8	4.0	14.4	4.0	18.4
III. Experimental	1961-63	Number	22	0	22	1	4	5	5	6	11	28	10	38
		Per Cent	13.0	--	13.0	0.6	2.4	3.0	3.0	3.6	6.5	16.5	5.9	22.4
	1963-65	Number	6	7	13	0	0	0	1	4	5	7	11	18
		Per Cent	4.8	5.6	10.4	--	--	--	0.8	3.2	4.0	5.6	8.8	14.4
IV. Curriculum	1961-63	Number	11	5	16	1	18	19	4	13	17	16	36	52
		Per Cent	6.5	3.0	9.5	0.6	10.7	11.3	2.4	7.7	10.1	9.5	21.3	30.8
	1963-65	Number	12	6	18	0	20	20	1	8	9	13	34	47
		Per Cent	9.6	4.8	14.4	--	16.0	16.0	0.8	6.4	7.2	10.4	27.2	37.6
V. Total	1961-63	Number	57	20	77	4	33	37	19	36	55	80	89	169
		Per Cent	33.8	11.9	45.5	2.4	19.5	21.9	11.2	21.2	32.6	47.4	52.6	100
	1963-65	Number	42	21	63	1	28	29	14	19	33	57	68	125
		Per Cent	33.6	16.8	50.4	0.8	22.4	23.2	11.2	15.2	26.4	45.6	54.4	100

In Category I, Survey and Status Studies, there was a large increase in the percentage of studies, both in number received and number reported. Conversely, the category Analytical Survey experienced a small drop and Experimental suffered a very large drop. Curriculum studies had the same trend as Survey studies. As one reads the abstracts the charges leveled by Dr. Benjamin Bloom in his presidential review for the Educational Researcher[4] begin to take an added meaning. He says:

"In the past, much of educational research has been fragmentary, redundant, and trivial. Educational research must be more systematic, and the investigations must be more crucial. Each piece of research must have a place in a larger conceptual framework. No longer can the same studies be done over and over again without taking into consideration what went on before or the advances which have taken place in theory and method. We must all learn how to do more crucial and significant research; redundant and poorly done research must be discouraged or, at least, questioned."

The increased funds available for educational research and recognition of the need for sound research activity should be an incentive for the National Association for Research in Science Teaching to re-evaluate the scope and usefulness of reports such as this one. Better abstracting (by independent evaluators) and collection and dissemination of educational research data will undoubtedly result from the efforts of the Educational Research Information Center (ERIC) of the U.S.O.E. Bureau of Research, which has now become operational. Perhaps NARST should explore possibilities of joining forces with the American Educational Research Association and Phi Delta Kappa both to broaden the scope and intensify the coverage of extant studies. Undoubtedly our present efforts, valuable though they may be, are but at best a sampling technique beset by inadequate resources and ineffectual and tardy dissemination techniques. In short, we need a much more businesslike approach to the issue of making immediately and widely known to the science education community current science education research. This problem has been discussed many times. Now is the time for action.

----

[4] February, 1966, p. 5.

There were few studies submitted in the areas of public policy, facilities and equipment, administration and supervision, teacher education, and evaluation. There were many curriculum studies and methods studies, but the committee felt that in many cases the samples were small or poorly selected, the studies were uniquely local in nature, or that inadequate or inappropriate evaluation instruments were used. Conclusions frequently represented the subjective judgment of the investigator and were not supported by adequate treatment of the data. The above criticism is not a blanket indictment of all of the abstracts examined. There were many fine studies that had ample data adequately treated. The committee, in general, would support the views of various contributors to the Journal of Research in Science Teaching, that much progress remains to be made in science education research, that science educators need to become more familiar with other educational, psychological, and sociological research, and that we have much farther to go before we can confidently say, "Science Education research says. . . . ."

Survey and Status Studies

Woodard (S-122) collected data through the State Department of Education in New York, and from a subsequent questionnaire through Cornell University to investigate science offerings, enrollments, and aspects of facilities and characteristics of science teachers of the State. He found that all academically able students in the schools studied had access to biology, chemistry, and physics courses, and that these courses usually integrally included laboratory work. Earth science was being added to junior high schools and greatest curriculum change was occurring at this level. Teachers were best prepared in biology, next chemistry, then physics. Earth science background was limited and more than fifty per cent of the teachers had three years or less tenure in their current positions. Morris (S-85) compared a total of 209 science and non-science teachers at elementary, junior high, and senior high levels on a number of characteristics. Among his conclusions were: The need for deference, for affiliation, and for conformity seemed to increase in science teachers with experience and age, science teachers at higher grade levels exhibited greater need for achievement, and both male and female teachers, regardless of their subject matter area, tend to exhibit striking similarity in their needs, values, and motives. In another study of teacher characteristics, Tubbs (S-112) attempted to determine differences in effective and less effective teachers. Questionnaire responses from 404 replies to a distribution of 994 teachers were analyzed. Each teacher was rated on an effectiveness scale by one class of pupils, the principal, and a group of fellow teachers. From the responses fifty-three teachers were designated as effective and forty-three were designated less effective. Seven characteristics were judged significantly different at the .01 level, eight at the .05 level, and five at the .10 level of confidence.

Bogen (S-11) appraised the effectiveness of the Oregon Traveling Science Teacher program as an agent for in-service training. He concluded that the program reached its objectives in that it stimulated interest and spread the influence of competent teachers of science, it encouraged the building of simple laboratory apparatus in smaller and poorly-equipped high schools, and it provided secondary school students with a deeper appreciation of science and helped motivate competent young people to enter scientific careers.

Etten (S-34) questioned 3000 teachers in 50 states. He concluded that while science studies, projects, surveys, and programs have been multiplying rapidly the average secondary school teacher seems to be maintaining the status quo, that there is a gap in the communications between science teachers, and that many teachers are making an effort to keep up with the fast pace of science. Van Houten (S-113) assembled and submitted a checklist to experienced chemistry and physics teachers. The 46 respondees rated the degrees of necessity for various skills and from an analysis of the responses recommendations for teacher training programs were made. Fisk (S-17) analyzed 1047 application forms submitted by teachers to academic year institute programs. He concluded that all applicants were deficient in some phase of their preparation, that, in general, they did not indicate that they recognized their deficiencies and thus did not indicate that they were interested in correcting them, and that the academic year institute programs in question did not meet the needs of applicants.

Ward (S-118) studied questionnaires from academic year institute directors and teachers of special institute courses. The data indicated that major objectives of the courses were to provide for basic review and to bring participants' knowledge up to date. Instructors were aware of the special needs of the teachers and felt that courses should carry graduate credit. Instructors generally felt that rigor of treatment was frequently sacrificed. Fisk (S-36) studied documents dealing with the historical development of educational activities of the National Science Foundation. He concludes that although the NSF science education programs were started as emergency measures, they now appear to be permanent and NSF is indeed becoming a Federal Educational Agency.

Bennett (S-6) surveyed current teaching practices in Texas junior high schools. He found that over half the schools used school time to encourage science fair work, that controversial issues are treated, and that only half of the school buildings have been designed specifically for that age group. A description of a typical junior high school is formulated, and the typical teacher is described. Johnson (S-62) studied the effect of radiation science institutes on secondary science programs of California. He concludes that teachers lack textbooks and laboratory manuals, that there is no formal provision in the course of study for such work, and that maintenance and calibration of equipment are teacher problems. The typical participant teaches four sections of biology and one of mathematics, and after institute training typically uses three periods of instruction per year per class of biology.

Parasugo (S-90) surveyed instructional programs in science for slow learners in ten junior high schools. He found that although homogeneous grouping was widely employed, there were few other modifications made in the ten academically-oriented junior high school studied. Fowler (S-38) studied the advanced biology course in Pennsylvania secondary schools. He found that of the 134 schools described, the course was more common in larger schools and has a prerequisite of biology, usually tenth grade. Almost without exception the course is considered a special course for college preparatory, terminal, or given a general education objective. Rarely is it considered advanced placement, and it commonly uses a "modern biology" approach. The taxonomy-structure approach was noticeably lacking.

Voss (S-116) evaluated the chemistry topics in BSCS Blue Version biology. A questionnaire listing 104 chemistry topics was submitted to 58 Blue Version teachers, and respondents indicated that biochemistry topics should be taught as part of the program; they were about equally divided on inclusion of basic chemistry topics. Fakier (S-35) determined the extent of the use of tests and other measurement techniques by high school biology teachers. A sample of 410 teachers was used and eleven conclusions were listed. No trend or pattern in regard to measurement practices or techniques could be established.

Morgan (S-83) did a thirty year longitudinal study of chemistry texts and popular literature of principles, vocabulary, and objectives. He found that little change has occurred, that methods of presentation differ primarily in emphasis placed on laboratory data and theoretical and mathematical considerations. Words and terms in the popular literature were contained to a greater extent in the traditional texts.

Weisberg (S-120) analyzed a 65 per cent return of 260 opinionnaires distributed to teachers and administrators to find attitudes toward the value and control of science projects in New Jersey secondary schools. He concluded that science projects were widely used despite the fact that the majority of principals and teachers believed that the projects were not valuable experiences for all students, that teacher structuring of projects was slight or non-existent in many cases (although this is not in keeping with what is suggested in the literature as good science project technique), and that science project work, in the main, was not truly experimental and therefore, at variance with what is generally accepted as most valuable and worthwhile for the acquisition of scientific knowledge and attitudes.

Matthews (S-80) sent questionnaires to 590 educational institutions to find the current status of earth science in secondary schools. He found that the interdisciplinary study is becoming increasingly common and is being taught as a separate course to almost 200,000 students in 50 states. The subject is usually offered in the 9th grade, but it is also taught in the 8th and 10th grades. Two major obstacles in teaching the course are (1) lack of suitable teaching materials, and (2) a scarcity of properly prepared teachers. In another study of earth science Kozak (S-69) found that the course is on the increase in New York state. The fundamentals have been taught for many years, and the basic material has remained similar since 1900.

Analytic Survey Studies

Hedges, MacDougall and Lochhead (S-51) analyzed teacher-made science tests to determine the teachers' educational goals. They found that the majority of the items reflected objectives classifiable among the lowest orders of Bloom's Taxonomy, and that the items were inadequately constructed. They conclude that science education in Virginia high schools is of a fragmentary and elementary nature, that science teachers are not giving sufficient consideration to the consolidation of broad understandings, and that science teachers appear to be insufficiently prepared in the construction of teacher-made tests. Kleinman (S-66) studied the relationship between teacher questions and pupil and teacher behaviors, and attempted to determine whether the kinds of questions general science teachers ask influence pupils' understanding of science. The study involved classroom observation in the seventh and eighth grades. Teachers were classified into two groups and the 767 pupils of 23 teachers were tested by the TOUS test. She found that there were significant differences at the .01 level of confidence on neutral, rhetorical, factual, clarifying, associative, and critical thinking question categories, that teachers who asked critical thinking questions rated higher on pupil and teacher behaviors than teachers who did not, that the 23 teachers demonstrated many similarities as well as differences in behavior, and that there were significant differences between pupils of both groups of teachers on six of eight comparisions of test scores.

Blankenship (S-10) studied the relationship of reactions to the BSCS program to selected teacher characteristics. He found that teachers who ranked higher on measures of capacity for independent thought and action and who had taught high school biology for three years or less reacted favorably to the BSCS program while those science teachers who ranked lower on measures of capacity for independent thought and action and who had been teaching high school biology for more than three years reacted unfavorably to the program. Howe (S-56) studied selected teacher factors and teaching methods in 51 Oregon tenth grade high school biology classes. He concluded, among others, that teachers rated high in personal adjustment by principals taught classes with higher adjusted gains on four of five learning outcomes, that teachers with less than forty quarter hours of preparation in all science areas and less than thirty quarter hours in biology, with one exception, did not teach classes with positive mean gains among the highest third on any of the learning outcomes, that pupil-centric methods emphasizing problem-solving laboratory procedures with analyses of experimentation were characteristic of a majority of the classes with a high composite success, and that several teachers in the study were not previously cognizant of broad objectives or were not including them in their teaching.

Matthews (S-79) investigated the changes in classroom verbal behavior of student teachers and the relation of the classroom verbal behavior of the cooperating teacher to these changes. He concludes that verbal behaviors of the student teachers exhibit significant change during the period of student teaching. Certain variations in verbal behavior may be related to the verbal behaviors of the coöperating teachers; in some aspects, student teachers become more similar to their cooperating teachers and in other aspects they become less similar to their cooperating teachers during the period of student teaching.

Zaki (S-124) found that there was a highly significant negative correlation between the attitude of Pakistani science teachers toward religion and their attitude toward science. He found that high school students in the United States understood that nature of the scientific enterprise significantly better than did the science teachers of West Pakistan, and that science teachers with a background in the biological sciences understood the nature of the scientific enterprise significantly better than did those who had studied only physical science.

Stokes (S-107), from a study of the proposals of the Woods Hole Conference concludes that the bacis assumptions about the nature of knowledge and the nature of learning germane to the position of the Woods Hole Conference have not been carefully investigated, that the advantages claimed for teaching the structure of a discipline have not been subjected to research even though such research is repeatedly called for by the report of the Conference, that the research on the effectiveness of the curriculum projects based on disciplinary structure is largely ambiguous, making it impossible to determine at present how effective the new programs are, and that the research on the effectiveness of learning by discovery as compared to nondiscovery methods was inconclusive for the six criteria used.

McFarland (S-81) examined teacher perceptions and reactions to system-wide adoption and implementation of Chemical Education Naterial Study materials of teachers who were involved in in-service workshops.

Indications were that the amount of time spent in various instructional activities did not change perceptibly, that special techniques for expediting equipment orders and instructional aids had to be developed, and that CHEMS experienced teachers assisted considerably in the implementations. The existence of distinct patterns of teacher response, he concluded, indicates a need for specifically tailored approaches to curriculum change within a given school system. Further, analysis of the student data indicates that new dimensions were added to the prediction of student achievement.

Nahrstedt (S-87) analyzed junior high school science programs which served as the basis of the development of twenty-five guides to aid in the revision of the junior high science curriculum.

Gomez (S-48) gave pre and post-tests to 814 students in 13 junior high schools in a study of sequential and non-sequential general science programs. He found, among others, that students in a general science program scored significantly higher than students in a sequential program, although there was no difference if the quality of instruction is high. There were differences in socio-economic level student scores, and in instruction using demonstrations.

Riggsby(S-92) studied the writing of scientists and content of textbooks in an investigation of scientific method. He concluded that the textbook approach is considerably more rigid and "objective" than scientists say it is in their actual practice, that many of the facets of the scientific method are of a personal nature to the scientist, and that many textbook writers confuse the logic the discovered with the logic of discovery.

Dessel (S-29) used a selected set of criteria to attempt to predict success in physics for high-ability students. He concludes that the letter grade is grossly inadequate but that certain standardized instruments have potential for use. In another study of factors operative in success in physics Brakken (S-12) analyzed intellectual factors of conventional and PSSC students. He found that differences exist between the two types of courses, that the conventional course is more verbally oriented, that achievement was dependent on verbal ability, and that the importance of this factor increased for conventional physics as instruction progressed, but that the trend did not appear for PSSC students.

Hamilton (S-50) compared the scientific literacy of urban, suburban, and rural high school seniors in Kentucky and concluded that scientific literacy depends upon mental ability, no conclusions can be drawn relative to scientific literacy of students from different areas, there is a positive relationship betweenthe number of science courses completed and scientific literacy, boys are not more literate scientifically than girls, and the size of the graduating class is not a contributing factor. In another study of achievement Giddings (S-46) studied disadvantaged students from junior high schools in New York. He found that high achievers had the active interest and strong encouragement of parents, they had a place that was conducive to study, there were more books, and magazines, in the homes, they showed much greater interest in science and careers in science, had a higher self-estimate of ability, and achieved better in other areas.

Braund and Heath (S-15) did a pilot study of a cognitive restructuring paradigm with four PSSC physics classes and concluded that devises such as the Kit of Reference Tests for Cognitive Factors and the Cognitive Preference Test can be useful in the analysis of curricular effects.

Vitrogen (S-115) developed a scale to measure a generalized attitude of secondary school students toward science. He concluded that a generalized attitude toward science can be identified among secondary school students 13 to 15 years of age, and that his instrument differentiated between high and low science oriented students in the study. In a study of interest Wynn (S-123) used the Kuder Preference Record to assess the change in scientific interest of high school students. Twenty-one per cent of the sample underwent significant change, although no significant relationships were established between Scientific Interest and Language IQ, Non-language IQ, Total IQ, academic achievement, science achievement, and biology achievement. The scientific interest scores of five successive classes did not indicate a trend of increasing interest in science.

Experimental Studies

Supplementary programmed instruction material used in conjunction with regular and team taught physical science classes was reported by Benson and Schorow (S-7). They conclude that sequentially paced materials using immediate reinforcement can be a valuable supplementary aid for the teacher, and that there is some evidence to indicate that programmed materials can be used to overcome deficiencies which teachers may possess either in the areas of academic preparation or interest. Lindbeck (S-75) also used programmed material to teach chemistry classes. She concludes that for a program teaching specific, detailed concepts, an overt response would seem to be most effective. For general concepts the covert response mode might be as effective.

Mahan (S-77) compared lecture-discussion and problem-solving methods of teaching ninth grade science. Two classes were used for each method and seven of the eight conclusions listed favored the problem-solving approach. No differences were found in the development of scientific attitudes.

Gallagher (S-42) sought to determine modifications in children's judgments after instruction in relevant physical principles. He concludes that children evaluate explanations on the basis of (a) logical structure, (b) physical principles, and (c) comprehensibility. The first generally results in the rejection of incomplete and logically inadequate explanations. Instruction in the logical structure of explanations appears to effect considerable change in children's views of acceptable explanations.

Coulters (S-25) compared the amount of learning in terms of inductive laboratory, inductive demonstration, and deductive laboratory instruction in biology. He concludes that the inductive treatments produced significantly greater attainment of attitudes of science. In no outcome was there a significant difference in favor of the deductive laboratory treatment. Gennaro (S-44) also did a comparative study of teaching biology using the BSCS Yellow Version and BSCS Laboratory Blocks with collateral reading. He found no significant differences between control and experimental classes except subject matter achievement for Block tests. Brosius (S-14) also used tenth-grade biology to compare two methods of laboratory instruction. He compared the use of films to actual dissections. He concludes on the basis of his self-constructed instruments that the films used could be substituted for conventional dissections in tenth-grade beginning biology without loss in the learning process and with more efficient use of time, space, and materials.

Curriculum Studies

A televised general science course was the basis for Jerkins (S-61) investigation of learning and retention. He found that the telecasts were most effective in teaching objectives at the lower extreme in the cognitive domain, that pre and post-test interest were stable, and that overall pupil and teacher reactions were favorable. Hunt (S-59), in another junior high school study investigated team teaching in science and social studies. He found that staff organizational patterns did not significantly affect academic or achievement or personality development, and there was some indication that team teaching was more successful at lower ability levels than higher ability levels.

Hubbard (S-57) used general science classes as a source of eighth graders to investigate junior high school students' perceptions of science and scientists by using an experimental and control group. The experimental group was taught a unit concerning scientists. Although no significant differences existed the experimental group scored slightly higher on the post-test.

George (S-45) compared conventional with BSCS biology in a study of their effects on critical thinking ability. He concluded that teachers must teach specifically for critical thinking, and that pupil achievement was significantly higher in Blue Version than Yellow Version and Yellow Version in turn was better than Green Version. There were no significant differences between Green and Yellow Versions and conventional.

In still another study involving biology, Morholt (S-84) used a resource unit as a means of teaching conceptual schemes by investigative approaches using a single organism.

Lisonbee (S-76) also compared BSCS biology with conventional biology. Experimental and control groups did not differ significantly on the Nelson Biology Test, but subgroups of middle and high ability tested higher on the BSCS Achievement Test.

Robinson (S-94) used instructional tests to determine understandings of BSCS biology students. Ten high school biology teachers met twice monthly during the school year to develop the series of clcassroom tests. The tests were in turn administered and evaluated. Standard techniques were used to check readability, reliability, and discrimination.

Hill (S-54) developed a syllabus for a course in biology for the non-academic high school student. He gathered data from non-academic students and their teachers and community adults who supervised out-of-school activities for the students.

In another study involving new curricula Herron (S-53) compared CHEM study with conventional chemistry in terms of their development of cognitive abilities. He used factor analysis to treat pre and post-test data and found that conventional low and average ability students scored significantly higher on the Watson-Glaser subtest, Recognition of Assumptions, than did the comparable CHEM study group. No other significant differences were found.

Day (S-28) compared PSSC physics and traditional physics in six areas of critical thinking. He concluded that students who take PSSC physics exhibit a greater ability to solve critical thinking problems and that non-PSSC students had a more positive attitude toward their physics courses.

Crumb (S-26) also used high school physics students and their teachers to study gains in scores on the Test on Understanding Science. He compared teachers of PSSC physics, both with and without formal PSSC training, and teachers of non-PSSC physics, both with and without formal PSSC training. Data were treated by analysis of variance and significant gains in understanding science were made by the entire study population over a period of a school year. Differences were found between PSSC and non-PSSC students. Sawyer (S-97) also studied the effectiveness of the PSSC course. A test was developed by four physics teachers, two PSSC and two non-PSSC, to be used with four physics classes as both pre-test and post-test. He concluded that the classes differed on the pre-test, the PSSC program does not fulfill non-PSSC objectives and vice versa, and that the tendency for students taking such a combination examination would favor higher scores for non-PSSC students. Rather (S-91) also used PSSC as the basis for a study to determine generalizations desirable as prerequisites to PSSC. He identified 223 generalizations and submitted them to a panel of teachers. He concluded that college and high school teachers disagreed as to (a) the ability of certain science terms to convey accurate scientific meaning, and (b) how accurately quantitative relationships should be expressed for pre-PSSC science courses.

APPENDIX A

Sources Examined for Research in Secondary Science Education

1. American Biology Teacher.
2. American Journal of Physics.
3. American School Board Journal.
4. American Scientist.
5. Audio-Visual Communication.
6. Audio-Visual Instruction.
7. Bulletin of the National Association of Secondary School Principals.
8. California Journal of Educational Research.
9. California Journal of Elementary Education.
10. California Schools.
11. Education.
12. Educational Administration and Supervision.
13. Educational Forum.
14. Educational Leadership.
15. Educational and Psychological Measurement.
16. Educational Research Bulletin.
17. Educational Screen and Audio-Visual Guide.
18. High Points.
19. Improving College and University Teaching.
20. Journal of Applied Psychology.
21. Journal of Chemical Education.
22. Journal of Educational Psychology.
23. Journal of Educational Research.
24. Journal of Educational Sociology.

25. Journal of Experimental Education.

26. Journal of General Education.

27. Journal of Higher Education.

28. Journal of Research in Science Teaching.

29. Journal of Secondary Education.

30. Journal of the Council for Exceptional Children.

31. Liberal Education.

32. Metropolitan Detroit Science Review.

33. National Association of Educational Broadcasters' Journal.

34. National Education Association Journal.

35. North Central Association Quarterly.

36. Peabody Journal of Education.

37. Phi Delta Kappan.

38. Physics Today.

39. Programmed Instruction (Bulletin).

40. Review of Educational Research.

41. Safety Education.

42. School and Society.

43. School Life.

44. School Science and Mathematics.

45. Science.

46. Science Course Improvement Projects (NSF Bulletin)

47. Science Education.

48. Scientific American.

49. Science Teacher.

50. Teaching Tools.

51. Today's Health.
52. The Catholic Education Review.
53. The Clearing House.
54. The Education Index.
55. The Educational Record.
56. The Physics Teacher.
57. The New York Times Index.
58. The Readers' Guide.
59. The Journal of School Health.
60. The School Review.
61. The Teachers College Journal.
62. The Teachers College Record.

APPENDIX B
AUTHORS AND TITLES FROM
1963-65 LITERATURE SEARCH

1. ABRAHAM, Norman. "The Interaction of Experiments and Ideas - A Separate B.S.C.S. - Second Course." Journal of Research in Science Teaching, Vol. 2, Issue 1, 1964. pp. 60-63.

2. ALTIERI, Donald P. "A Challenge to Science Oriented Students." The Science Teacher, Vol. 31, No. 3, April, 1964. p. 42.

3. ANDERSON, Kenneth E. "A Comparative Study of Student Self-Ratings of Inspirational Teachers in Science and Mathematics in the Development of Intellectual Curiosity, Persistence, and a Questioning Attitude." Science Education, Vol. 47, No. 5, December, 1963. pp. 429-437.

4. BACUNGAN, Cloefe M. "A College-Preparatory Chemistry Course for Philippine Secondary Schools." Dissertation Abstracts, Vol. XXIV, No. 11, 4464, Order No. 64-3348.

5. BADEN, Walter D. "The Focus of High School, 1957-1962: An Analysis of Changes in Curriculum Balance in Four Selected Senior High Schools on Long Island, New York, Since October, 1957." Dissertation Abstracts, Vol, XXIV, No. 8, 3159, Order No. 64-1463.

6. BAEZ, Albert U. "UNESCO Pilot Project on New Methods of Physics Teaching in Brazil." Reported in American Journal of Physics, Vol. 32, No. 10, October, 1964. p. 816.

7. BARFIELD, Arthur D. "Virginia's Beginning Science Teachers, 1958-59." Science Education, Vol. 47, No. 4, October, 1963. pp. 397-401.

8. BARSTOW, William; MASON, Herbert; and HAUGH, Thomas. "A Report on Team Teaching Adapted to a Standard Secondary School Curriculum." The American Biology Teacher, Vol. 26, No. 5, May, 1964. pp. 363-65.

9. BAUMEL, Howard B. "The Effects of a Method of Teaching Secondary School Biology which Involves the Critical Analysis of Research Papers of Scientists on Selected Science Education Objectives." Dissertation Abstracts, Vol. XXIV, No. 3, 1090, Order No. 63-6657.

10. BENNETT, Lloyd M. "A study of the Comparison of Two Instructional Methods; The Field Method and the Classroom Method, Involving Science Content in Ecology for the Seventh Grade." Dissertation Abstracts, Vol. 25, Part 1, 318, Order No. 64-7511.

11. BENNETT, Lloyd M. "Determining the Feasibility of Presenting a Marine Biology Unit in Ecology to Average Seventh Graders." School Science and Mathematics, Vol. LXIV, No. 4, April, 1964. pp. 306-11.

12. BERGEN, Catharine. "Student Understanding of Science Textbook Reading." School Science and Mathematics, Vol. LXIII, No. 9, December, 1963. pp. 763-66.

13. BERGER, Joel J. "A Determination of the Relative Effectiveness of Two Specific Teaching Methods on the Ability of High School Chemistry Students to Write Chemical Formulas and to Apply This Knowledge to a New Problem-solving Situation." Dissertation Abstracts, Vol. XXIV, No. 7, 2806, Order No. 64-236.

14. BICAK, Laddie J. "Achievement in Eighth-Grade Science by Heterogeneous and Homogeneous Classes." Doctors Thesis - Minneapolis; University of Minnesota, 1962. 207 pp.
Dissertation Abstracts, 23:2367-8; No. 7, 1963.

15. BICAK, Laddie J. "Achievement in Eighth Grade Science by Heterogeneous and Homogeneous Classes."
Science Education, Vol. 48, No. 1, February, 1964. pp. 13-22.

16. BLANCHARD, B. Everard. "Abilities of High School Freshman to Engage in Research Work."
The Journal of Educational Research, Vol. 57, No. 8, April, 1964. pp. 443-44.

17. BOGEN, Gerald K. "The Traveling Science Teacher Demonstration Program and In-Service Education."
Journal of Research in Science Teaching, Vol. 2, Issue 1, 1964. pp. 69-72.

18. BOWEN, John J. "Topic Preferences of Boys and Girls in School Science Exhibits."
School Science and Mathematics, Vol. LXIV, No. 1, January, 1964. pp. 47-52.

19. BREEDLOVE, Charles B. "An Appraisal of Team Teaching in High School Chemistry."
Dissertation Abstracts, Vol. 25, Part 1, 178. Order No. 64-5096.

20. BROGDON, Wallace M. "An Analysis of Certain Factors Pertinent to Science Education Programs in Georgia High Schools."
Dissertation Abstracts, Vol. 25, Part 1, 179. Order No. 63-1945.

21. BROWNSON, William E. and SCHWAB, Joseph J. "American Science Textbooks and Their Authors, 1915 and 1955."
The School Review, Vol. 71, No. 2, Summer, 1963. pp. 170-80.

22. BRUCE, Mathew H. and JOHNSON, Phillip G. "School-Centered Research Experience for Science Teachers."
The Science Teacher, Vol. 30, No. 5, September, 1963. pp. 16-20.

23. BUNNELL, Robert A. and CAMPBELL, Ronald F. "Differential Impact of National Programs on Secondary Schools."
School Review, Vol. 71, No. 4, Winter, 1963. pp. 464-476.

24. BURKMAN, Ernest. "A Science Teaching Center for the Southeastern States."
The Science Teacher, Vol. 30, No. 8, December, 1963. pp. 23-5.

25. BUTTS, David P. "The Evaluation of Problem Solving in Science."
Journal of Research in Science Teaching, Vol. 2, Issue 2. pp. 116-122. 1964.

26. CAIN, Ralph W. and LEE, Eugene C. "An Analysis of the Relationship Between Science and Mathematics at the Secondary Level." School Science and Mathematics, Vol. LXIII, No. 9, December, 1963. pp. 705-11.

27. CALANDRA, Alexander. "A Program in Science and Mathematics." American Journal of Physics, Vol. 32, No. 11, November, 1964. p. 835.

28. CAMPBELL, Vincent N. "Bypassing As a Way of Adapting Self-Instruction Programs to Individual Differences." Journal of Educational Psychology. 54: pp. 337-45, December, 1963.

29. CANNON, Robert L. "Science Supervision in Texas Public Schools, 1960-61." School Science and Mathematics, Vol LXIV, No. 3, March, 1964. pp. 203-16.

30. CHAPLIN, H.G. Basil. "The Re-planning of Junior Science Education in West Africa." Science Education, Vol. 48, No. 3, October, 1964. pp. 366-70.

31. CHAPMAN, John M., CALDWELL, Loren L. "A Content Study of Earth Science Courses in Selected Secondary Schools." Science Education, Vol. 48, No. 5, December, 1964. pp. 430-436.

32. CHARAN, Das Radha. "The Problem Development Method: An Experimental Try-out in the Teaching of Science in Secondary Schools." Science Education, Vol. 48, No. 5, December, 1964. pp. 485-488.

33. CHRISTIAN, Donald D. "Trends in the Science Curriculum in the Public High Schools of Pennsylvania for the School Years 1954-55 Through 1958-59." Dissertation Abstracts, Vol. XXIV, No. 3, 1093, Order No. 63-6372.

34. CLINE, Victor; RICHARDS, James, Jr.; and NEEDHAM, Walter. "Factor Analysis of Self Ratings, Teacher Ratings, and Indices of Achievement in High School Science." Journal of Educational Research, Vol. 58, No. 1, September, 1964. pp. 10-15.

35. COASH, John R. "Earth Science in Secondary Schools." Geotimes 7, 1963. pp. 26-29.

36. COLLINS, E. Hobart. "Changes Which Occurred in the Teaching of Physics Over a Period of Twenty Years." American Journal of Physics, Vol. 32, No. 9, September, 1964. p. 718.

37. COOLEY, William W. "The Potential Scientist Pool." Journal of Research in Science Teaching, Vol. 2, Issue 1, 1964. pp. 24-32.

38. COOLEY, William W. "Predicting Choice of a Career in Scientific Research." Personnel and Guidance Journal, September, 1963, Vol. XLII, No. 1.

39. COWAN, Paul J. "An Auto Instructional Program in PSSC Physics for Small Schools." American Journal of Physics, Vol. 32, No. 10, October, 1964, p. 815.

40. COWAN, Paul J. "Development of New Auto Instructional Materials and an Analysis of Their Effectiveness in Teaching Modern Physics In the Small High School." Dissertation Abstracts, Vol. 25, No. 5, 2879, Order No. 64-11787.

41. COX, Hiden T. "Modern Biology: A Unifying Science, Part 1: The AIBS Film Series." Journal of Secondary Education, Vol. 38, No. 8, December, 1963. pp. 105-108.

42. CRAIG, Robert C. and HOLSBOCK, Sister M. Celestine. "Utilizing Existing Interests to Develop Others in General Science Classes." School Science and Mathematics, Vol. LXIV, No. 2, February, 1964. pp. 120-8.

43. CRANE, H. R. "Remedial Programs." American Journal of Physics, Vol. 32, No. 6, June, 1964. pp. 465-473.

44. CUSICK, James W. "An Analysis of Chemical Bond Principles in an Experimental Introductory Chemistry Course." Dissertation Abstracts, Vol, XXV, No. 4, 2374, Order No. 64-10814.

45. CUSICK, James W. "An Analysis of Chemical Bond Principles in an Experimental Introductory Chemistry Course." Dissertation Abstracts, Vol. 25, No. 4, 2374, Order No. 64-10814.

46. DAY, William F. "An Experimental Evaluation of PSSC and Traditional Physics in Six Areas of Critical Thinking." American Journal of Physics, Vol. 32, No. 11, November, 64. p. 901.

47. DELOACH, Will S. "Organic Chemistry Tests - An Analysis." Journal of Research in Science Teaching, Vol. 2, Issue 1, 1964. pp. 51-57.

48. DESSEL, Norman F. "Prediction of Success in Physics for High Ability Students - A Small Sample Study." American Journal of Physics, Vol. 32, No. 3, March, 1964, pp. 197-99.

49. DOLE, Arthur and SHERMAN, Ruth. "Determinants of the Choices of a Science Program by Ninth Grade Males." Journal of Educational Research, Vol. 58, No. 3, November, 1964. pp. 99-105.

50. DRESSEL, Norman F. and YAGER, Robert E. "Selection Criteria for High Ability Science Students."
Journal of Educational Research, Vol. 57, No. 4, December, 1963. pp. 193-196.

51. ECCLESTON, Teresa. "The Determination of the Technical Vocabulary of Science in the Sixth and Seventh Grades."
Master's thesis, The Catholic Educational Review, March 1964, Vol. LXII, No. 3, pp. 190-1.

52. EVEN, Robert L. "An Experimental Study of the Comparative Effect of Selected Art Experiences on the Creative Performance and Attitudes of Academically Superior Students."
Dissertation Abstracts, Vol. XXIV, No. 11, 4470, Order No. 64-4062.

53. FENTON, Edwin. "Curriculum Development for Able High School Students at Carnegie Institute of Technology."
ICSS Newsletter, Vol. 6, No. 1, November-December, 1963. p. 11.

54. FERGUSON, Milton L. "A Summer High School Program for Academically Talented Students in Mathematics and Science."
Science Education, Vol. 47, No. 4, October, 1963. pp. 382-386.

55. FERRIS, Frederick L., Jr. "The Princeton Junior High School Project."
Journal of Research in Science Teaching, Vol. 1, Issue 3, 1963. pp. 281-284.

56. FIASCA, Michael. "Portland Tries Integrated Science Course."
The Science Teacher, Vol. 31, No. 1, February, 1964. p. 39.

57. FISH, Alphoretta S. "A State Department Plans for Science Curriculum Development."
Educational Leadership, Vol. 21, No. 5, February, 1964. pp. 301-4.

58. FLORA, Charles. "Rapport and the Cyclopean Eye."
Science Education, Vol. 48, No. 5, December, 1964. pp. 396-404.

59. FRANKLIN, W. R. "A Study in Students' Reactions."
The Science Teacher, Vol. 31, No. 8, December, 1964. pp. 11-15.

60. FRYE, Orion Frederick. "A Study of the Effects of the National Defense Education Act of 1958 on Science Programs of Some Selected High Schools in the State of West Virginia."
Dissertation Abstracts, Vol. XXIV, No. 4, 1962. Order No. 63-4633.

61. FULLERTON, Bill J. and LISONBEE, Lorenzo. "The Comparative Effect of BSCS and Traditional Biology on Student Achievement."
School Science and Mathematics, Vol. LXIV, No. 7, October, 1964. pp. 494-98.

62. GATEWOOD, Claude. "A Study of the Effect of the Oklahoma State University Traveling Science Teacher Program on the Attitudes of High School Students Toward Science and Scientists." <u>Dissertation Abstracts</u>, Vol. XXIV, No. 1, 189, Order No. 63-4051.

63. GAVERICK, Charles M. "Retention of School Learning as Influenced by Selected Affective Tone Variables." <u>Journal of Educational Psychology</u>, 1964, Vol. 55, No. 1, pp. 31-34.

64. GIBSON, Mrs. Caroline A. "The Progress of the Junior High School Program (Exploration In The Sciences)." <u>The American Biology Teacher</u>, Vol. 26, No. 7, November, 1964. p. 518.

65. GLASER, Robert and REYNOLDS, James. "Effects of Repetition and Spaced Review Upon Retention of a Complex Learning Task." <u>Journal of Educational Research</u>, 1964, Vol. 55, No. 5, pp. 297-308.

66. GOLDSTEIN, Norman, Jr. "Instrumentation and the Teaching of Science." <u>The American Biology Teacher</u>, Vol. 25, No. 8, December, 1963. pp. 585-588.

67. GROBMAN, Hulda. "High School Biology -- On What Level Does It Belong." <u>The Clearing House</u>, Vol. 38, No. 8, April, 1964. pp. 498-99.

68. GROBMAN, Hulda. "Student Performance in New High School Biology Programs." <u>Science</u>, Vol. 143, No. 3603, 1964.

69. GROSS, Leo and MOLOMUT, Norman and SIMENDINGER, Elizabeth. "A Summer in Science Research." <u>The Science Teacher</u>, Vol. 31, No. 3, April, 1964. pp. 31-33.

70. GRUVER, William J. "Can Your High School Afford the New Science Programs?" <u>School Life</u>, Vol. 46, No. 4, January-February, 1964. pp. 5-7.

71. HAWKINS III, Charles E. "A Comparison of the Environmental, Personality and Intellectual Characteristics of Two Groups of Male, Secondary School Students, Equal in Intelligence as Measured by Standardized Instruments but Unequal in Creative Ability." <u>Dissertation Abstracts</u>, Vol. 25, No. 3, 1745, Order No. 64-8830.

72. HEATH, Robert W., and STICKELL, David W. "CHEM and CBA Effects on Achievement in Chemistry." <u>The Science Teacher</u>, Vol. 30, No. 5, September, 1963. pp. 45-46.

73. HEILEMAN, John J. "Junior High School Physics." <u>American Journal of Physics</u>, Vol. 32, No. 3, March, 1964. p. 240.

74. HENDERSON, Lavaniel Sr. "The Development of a Science Course for Elementary Teachers: A Cyclic Process." <u>Science Education</u>, Vol. 47, No. 4, October, 1963. pp. 402-404.

75. HELLER, Robert L. "The Earth Science Curriculum Project."
Journal of Research in Science Teaching, Vol. 1, Issue 3, 1963. pp. 272-275.

76. HILL, Casper W. "A Syllabus of a Course in General Biology for the Non-Academic Student in High School."
Dissertation Abstracts, Vol. XXIV, No. 7, 2811, Order No. 64-283.

77. HILL, Russel Norman. "An Analytic Survey of Curricular Changes in Minnesota Schools, 1951-1962."
Dissertation Abstracts, Vol. XXIV, No. 11, 4471, Order No. 64-4065.

78. HOFFMASTER, Edmund, LATHAM, James, and WILSON, Elizabeth. "Design for Science."
The Science Teacher, Vol. 31, No. 7, November, 1964. pp. 15-17.

79. HONNEN S. S. J., James F. "The History of Chemistry Teaching in Catholic High Schools of the New York Archdiocese."
Dissertation Abstracts, Vol. 25, No. 5, 2884, Order No. 64-11299.

80. HOWE, Robert W. "The Relationship of Learning Outcomes to Selected Teacher Factors and Teaching Methods in Tenth Grade Biology Classes in Oregon."
Dissertation Abstracts, Vol. 25, Part 1, 190, Order No. 64-7420.

81. HUBBARD, Howard Newton. "Junior High School Students' Preceptions of Science and Scientists."
Dissertation Abstracts, Vol. XXIV, No. 12, Part 1, 5244.

82. HUNT, Edward George. "Team Teaching in Junior High School Science and Social Studies."
Dissertation Abstracts, Vol. XXIV, No. 11, 4583, Order No. 64-3538.

83. HUTTO, Thomas A. "A Need for Coordination of Science Youth Activities."
School Science and Mathematics, Vol. LXIV, No. 7, October, 1964. pp. 625-28.

84. JACKSON, Harold F. "The Effectiveness of Using Filmed Courses in Physics and Chemistry in Addition to the Traditional Lecture-Laboratory Courses in High School."
Dissertation Abstracts, Vol. XXIV, No. 1, 199, Order No. 63-4503.

85. JACOBELLI, Anthony. "A Special Honors Three in One Biology Course."
The Clearing House, Vol. 38, No. 3, November, 1963. p. 172.

86. JOHNSON, Paul E. "Associative Meaning of Concepts in Physics."
Journal of Educational Psychology, 1964, Vol. 55, No. 2, pp. 84-88.

87. JONES, George L. "An Enrichment Program in Chemistry for the Advanced High School Student."
Journal of Chemical Education, Vol. 40, No. 11, November, 1963. p. 605.

88. JONES, James W. "The Physical Science Programs in the Senior High Schools of Arkansas."
Dissertation Abstracts, Vol. 25, No. 3, 1655, Order No. 64-10067.

89. JONES, Kenneth. "Interest, Motivation, and Achievement in Science." The Journal of Experimental Education, Vol. 33, No. 1, Fall, 1964. pp. 41-53.

90. JONES, Kenneth J. "Predicting Achievement in Chemistry: A Model." Journal of Research in Science Teaching, Vol. 1, Issue 3, 1963. pp. 226-231.

91. KAPLAN, Eugene H. "Empiricism as a Function of Training in the Scientific Method." Journal of Research in Science Teaching, Vol. 1, Issue 4, 1963. pp. 329-340.

92. KASTRINOS, William. "Teaching for Critical Thinking in High School Biology." Journal of Research in Science Teaching, Vol. 1, Issue 4, 1963. pp. 341-50.

93. KEFFER, Eugene R. "The Use of Expert Judgments in the Development of a Science Methods Course." Journal of Experimental Education, Vol. 33, No. 1, Fall, 1964. pp. 55-59.

94. KLAUSMEIER, Herbert J. and WIERSMA, William. "Effects of Condensing Content in Mathematics and Science in the Junior and Senior High School." School Science and Mathematics, Vol. LXIV, No. 1, January, 1964. pp. 4-11.

95. KLOPFER, Leopold. "The Use of Case Histories in Science Teaching." School Science and Mathematics, Vol. LXIV, No. 8, November, 1964. pp. 660-66.

96. KOELSCHE, Charles L. "Science Education Programs in the Developing Countries of South and Southwest Asia." Science Education, Vol. 48, No. 3, October, 1964. pp. 344-350.

97. KUETHE, James L. "Science Concepts: A Study of Sophisticated Errors." Science Education, Vol. 47, No. 4, October, 1963. pp. 361-364.

98. LANCE, Mary L. "A Comparison of Gains in Achievement Made by Students of BSCS High School Biology and Students of a Conventional Course in Biology." Dissertation Abstracts, Vol. 25, No. 5, 2814, Order No. 64-11708.

99. LERNER, Morris. "Integrated Science." The Science Teacher, Vol. 31, No. 1, February, 1964. pp. 37-39.

100. LISONBEE, Lorenzo K. "The Comparative Effect of BSCS and Traditional Biology Upon Student Success." Dissertation Abstracts, Vol. XXIV, No. 8, 3153, Order No. 64-2186.

101. LOCKE, Edwin A. "The Development of Criteria of Student Achievement." Educational and Psychological Measurement, Vol. XXIII, No. 2, 1963. pp. 299-307.

102. LOCKE, Edwin. "Some Correlates of Classroom and Out of Class Achievement in Gifted Science Students." Journal of Educational Psychology, 1963. Vol. 54, No. 5, pp. 238-48.

103. LOZANOFF, Paul. "ST-TOP: Specialized Teaching - The Orange Program." The American Biology Teacher, Vol. 26, No. 5, May, 1964. pp. 366-68.

104. LYON, Margaret Charters. "Evaluation as an Integral Part of a Summer Science Program for Talented High School Students." Science Education, Vol. 47, No. 4, October, 1963. pp. 377-382.

105. MAHAN, Luther. "The Effect of Problem Solving and Lecture Discussion Methods of Teaching General Science in Developing Student Growth in Basic Understandings, Problem-solving Skills, Attitudes, Interests, and Personal Adjustment." Dissertation Abstracts, Vol. XXIV, No. 3, 1097, Order No. 63-6308.

106. MALLINSON, George. "Junior High School and the Implications of the Science Motivation Project". Re: Science Motivation Project." School Science and Mathematics, Vol. LXIV, No. 7, October, 1964. pp. 613-23.

107. MAYRHOFER, Al. Experimentation with the Green Version of BSCS Materials as reported in "What's Happening." Journal of Secondary Education, Vol. 38, No. 6, October, 1963. pp. 31-2.

108. MAYRHOFER, Al. "Study on Comparison of BSCS and AIBS Films." Journal of Secondary Education, Vol. 38, No. 6, November, 1963. p. 32.

109. MCCLOSKEY, James. "The Development of the Role of Science in General Education for Elementary and Secondary School." Dissertation Abstracts, Vol. XXIV, No. 8, 3194, Order No. 64-1870.

110. MCFALL, Robert W. "The Development and Validation of an Achievement Test for Measuring Higher Level Cognitive Processes in General Science." Journal of Experimental Education, Vol. 33, No. 1, Fall, 1964. pp. 103-106.

111. MERRILL, John H., and ROMEY, William D. "A Comparison of the Performance of Ninth-Grade and College Students in an Earth Science Laboratory Activity." The Science Teacher, Vol. 31, No. 4, May, 1964. pp. 49-52.

112. MERRILL, Reed M., and JEX, Frank B. "Role Conflict in Successful Science Teachers." Journal of Educational Research, Vol. 58, No. 2, October, 1964. pp. 72-74.

113. MILLER, Phillip E. "Do the Low Achievers Fit In?" School Science and Mathematics, Vol. LXIV, No. 5, May, 1964. pp. 399-403.

114. MONTAG, Betty Jo., DURBRIDGE, Walter, and SAMUELS, William. "TV vs. Overcrowding in General Science." The Science Teacher, Vol. 31, No. 3, April, 1964. pp. 42-55.

115. MONTAGUE, Earl J. "An Attempt to Appraise Whether Problem-Solving Abilities Can Be Developed in a General Chemistry Laboratory." The Science Teacher, Vol. 31, No. 2, March, 1964. pp. 37-38.

116. MORHOLT, Evelyn. "The Use of Chorella to Teach Conceptual Schemes and Experimental Approaches in Biology. A Resource Unit to Illustrate the Use of an Organism as a Focus for the Development of Ideas Central to a Course of Study." Dissertation Abstracts, Vol. 25, Part 1, 45, Order No. 64-4330.

117. MORIARTY, Barry M. "Science for the Intelligent Adult of the Future." The Science Teacher, Vol. 31, No. 7, November, 1964. pp. 18-19.

118. MORRISSEY, Sister M. Chrysoston. "A Study of the Predictive Value of High School Science Grades as Indicators of Success in Anatomy and Physiology in Selective Schools of Nursing." The Catholic Educational Review, Vol. LXI, No. 7, October, 1963. p. 480.

119. MUNSON, Norma F. "A High School Biology Laboratory Manual." Dissertation Abstracts, Vol. XXIV, No. 3, 1033, Order No. 63-6310.

120. NEWTON, David E. "The Role of Science in General High School Education." School Science and Mathematics, Vol. LXIV, No. 6, June, 1964. pp. 550-2.

121. NICHOLS, Robert. "Career Decisions of Very Able Students." Science, Vol. 144, June, 1964. p. 1315.

122. NOHRSTEDT, Gary W. "An Analysis of the Junior High School Science Program with Proposed Guides for Curriculum Revision." Dissertation Abstracts, Vol. XXIV, No. 8, 3233, Order No. 64-1539.

123. OLSTAD, Roger G. "Secondary School Biology Achievement Related to Class Period Length and Teaching Method." Dissertation Abstracts, Vol. XXIV, No. 5, 1943, Order No. 63-7945.

124. O'REILLY, Lawrence. "Let's Get the Health Out of Science." Journal of School Health, Vol. XXXIV, No. 4, April, 1964. p. 153.

125. ORR, David B. and YOUNG, Albert T. "Who Attends NSF Institutes." The Science Teacher, Vol. 30, No. 7, November, 1963. pp. 39-40.

126. PERISHO, Clarence R. "A Problem-solving Test: The Construction of a Manipulative Performance Test Designed to Induce the Collection and Use of Perceptive Data in the Formulation and Inferential Verification of Hypotheses." Dissertation Abstracts, Vol. XXIV, No. 5, 1888, Order No. 63-6674.

127. PELLA, Milton O. and POULOS, Chris. "A Study of Team Teaching in High School Biology." Journal of Research in Science Teaching, Vol. 1, Issue 3, 1963. pp. 232-40.

128. PETERSON, David W. "The Ability of High School Seniors to Identify and Apply Biological Principles in Problem Solving Situations." Dissertation Abstracts 23:2450 - 1, No. 7, 1963.

129. PORTIS, A. M. "The Berkeley Physics Laboratory." American Journal of Physics, Vol. 32, No. 6, June, 1964. pp. 458-464.

130. PRASAD, lena Sri Bishnu. "An Analysis of Errors of Pupil Teachers Teaching General Science in Criticism Lessons." Science Education, Vol. 48, No. 5, December, 1964. pp. 488-490.

131. PULLIAM, Mabel G. "An Analysis of Selected Outdoor Education Programs and Recommendations for Curriculum and In-Service Education for the Outdoor Education Program of the Jefferson County Colorado Public Schools." Dissertation Abstracts, Vol. 25, Part 1, 200, Order No. 64-6308.

132. RAINEY, Robert G. "A Comparison of the CHEM Study Curriculum and a Conventional Approach in Teaching High School Chemistry." School Science and Mathematics, Vol. LXIV, No. 6, June, 1964. pp. 539-44.

133. RAINEY, Robert G. "The Effects of Directed Versus Non-Directed Laboratory Work on High School Chemistry Achievement." Dissertation Abstracts, Vol. XXIV, No. 1, 146, Order No. 63-4331.

134. RASMUSSEN, Del. "Sam - A Correlated Sequence in Science and Mathematics." The Science Teacher, Vol. 31, No. 3, April, 1964. pp. 36-38.

135. RAUB, Stanley. "An Adventure in Excellence With a Community Resources Project." School Board Journal, Vol. 147, No. 2, August, 1963. pp. 7-9.

136. RENNER, John W. "Science and the Communication Skills." The Science Teacher, Vol. 30, No. 6, October, 1963. pp. 26-27.

137. RENNER, John W. "Senior High School Students and the Scientist, Engineer, and Technician." School Science and Mathematics, Vol. LXIV, No. 6, June, 1964. pp. 513-17.

138. RICHARDS, James M., Jr.; CLINE, Victor; and ABE, Clifford. "Use of a Biographical Information Blank in the Prediction of Achievement in High School Science." Educational and Psychological Measurement, Vol. XXIII, No. 4, 1963. pp. 789-798.

139. RICHMAN, Paul T. "The Effect of Prestige Suggestion On Science Teachers' Acceptance of New Curriculum." Dissertation Abstract, Vol 25, Part 1, 328, Order No. 64-5564.

140. ROBINSON, James T. "An Investigation of Selected Frameworks of Science." Dissertation Abstracts, Vol. 25, No. 3, 1791, Order No. 64-9807.

141. ROBINSON, James T. "Developing Instructional Tests for High School Biology." California Education, Vol. 1, No. 4, February, 1964.

142. ROBINSON, James T. "Science In The High School." California Education, Vol. 1, No. 4, February, 1964.

143. ROSS, William H. Team Teaching in Ninth Grade Science as reported in "What's Happening." Journal of Secondary Education, Vol. 38, No. 6, October, 1963. pp. 34-5.

144. RUPEL, Dorothy D. "A Carrousel for Independent Study." The Science Teacher, Vol. 30, No. 8, December, 1963. pp. 14-15.

145. SAINT-ROSSY, Dan Dr., "A Report Concerning Some Problems in Secondary Science and Mathematics Education in the Republic of China." Science Education, Vol. 48, No. 5, December, 1964. pp. 468-478.

150. SAMS, Earl W. "Summary of Science Course Data from 1963 October Report of High Schools." California Education, Vol. 11, No.1, September, 1964. p. 8.

151. SAWYER, Robert. "An Investigation of the Effectiveness of the Program Recommended by the Physical Science Study Committee." Dissertation Abstracts, Vol. XXIV, No. 12, Part 1, 5254.

152. SCHENBERG, Samuel. "Industry Comes to the Classroom." The Science Teacher, Vol. 31, No. 3, April, 1964. pp. 38-39.

153. SCHLESSINGER, Fred. "Science Facilities for Our Schools." The Science Teacher, Vol. 30, No. 8, December, 1963.

154. SCOTT Jr., Norval C. "Science Concept Achievement and Cognitive Functions." Journal of Research in Science Teaching, Vol. 2, Issue 1, 1964. pp. 7-16.

155. SHIPMAN, James T. "Research Participation for High School Students." American Journal of Physics, Vol. 32, No. 3, March, 1964. p. 241.

156. SHOEMAKER, Joseph L. "A Study of the Differences of Comprehension That Pupils in Colorado Secondary Schools Have of Twenty Selected Science Words." Dissertation Abstracts, Vol. XXIV, No. 11, 4488, Order No. 64-1943.

157. SHOWALTER, Victor. "Unified Science - An Alternative to Tradition." The Science Teacher, Vol. 31, No. 1, February, 1964. pp. 24-26.

158. SLESNICK, Irwin L. "The Effectiveness of a Unified Science in the High School Curriculum." Journal of Research in Science Teaching, Vol. 1, Issue 4, 1963. pp. 303-14.

159. SLESNICK, Irwin. "The Effectiveness of a Unified Science in the High School Curriculum." Dissertation Abstracts, Vol. XXIV, No. 1, 204, Order No. 63-4702.

160. SMAWLEY, Robert B. "Compact Item Analysis of Classroom Tests: A Brief Supplement to Bennett's Simple Use of Statistics." Science Education, Vol. 48, No. 5, December, 1964. pp. 427-430.

161. SMEDLEY, Albert E. "Apparatus for Junior High School Science." The Science Teacher, Vol. 30, No. 8, December, 1963. pp. 32-4.

162. SMEDLEY, Albert E. "Development of a List of Apparatus to be Used in Junior High School Science Classes." Dissertation Abstracts, Vol, XXIV, No. 8, 3157, Order No. 64-1693.

163. SMITH, Gary R. "Time Lapse Camera Records." School Science and Mathematics, Vol. LXIII, No. 7, October, 1963. pp. 573-78.

164. SMITH, Paul M. Jr. "Critical Thinking and the Science Intangibles." Science Education, Vol. 47, No. 4, October, 1963. pp. 405-407.

165. SPIETH, Phillip E. "Intelligence As It Relates to Three Creativity Categories: Science, Art, and Literature." Dissertation Abstracts, Vol. 25, No. 3, 1759, Order No. 64-8212.

166. STAPP, William B. "Developing a Conservation Education Program for the Ann Arbor Public School System and Integrating it Into the Existing Curriculum (K-12) with Volume II: Appendices." Dissertation Abstracts, Vol. XXIV, No. 10, 4057, Order No. 46892.

167. STEPHENSON, Robert C. "The Earth Science Curriculum Project." The Science Teacher, Vol. 31, No. 2, March, 1964. pp. 21-23.

168. STEWART, John L. "A Report on the Training of Science Student Teachers for the Secondary Schools at North Carolina College at Durham." School Science and Mathematics, Vol. LXIV, No. 3, March, 1964. pp. 271-81.

169. STOKES, William W. "An Analysis and Evaluation of Current Efforts to Improve the Curriculum by Emphasis on Disciplinary Learning Structure and Learning by Discovery." Dissertation Abstracts, Vol. 25, Part 1, 329, Order No. 64-7893.

170. STONE, Ruth. "A Comparison of the Patterns of Criteria Which Elementary and Secondary School Teachers Use in Judging the Relative Effectiveness of Selected Learning Experiences in Elementary Science." Dissertation Abstracts, Vol. XXIV, No. 3, 1037, Order No. 63-6681.

171. STOUT, Edmond B. "The Relationship Between Achievement and Underachievement in 'Average' Ability Tenth Grade High School Students with Physical Growth and Selected Factors in Their School and Extra-school Activities." Dissertation Abstracts, Vol. XXIV, No. 7, 2792, Order No. 64-1131.

172. STREHLE, Joseph A. "The Comparative Achievement of Seventh Grade Exploratory Science Students Taught By Laboratory Vs. Enriched Lecture Demonstration Methods of Instruction." Dissertation Abstracts, Vol. 25, No. 4, 2386, Order No. 64-10618.

173. TATARA, Walter T. "Effects of Novels on Ideas About the Scientist." Journal of Educational Research, Vol. 58, No. 1, September, 1964. pp. 3-9.

174. TERRY, Richard E., and WEISHAR, William. "Our First Year Under BSCS." The American Biology Teacher, Vol. 26, No. 5, May, 1964. pp. 345-6.

175. THELEN, L. J. "Facts and Concepts of Chemistry of Importance for Introductory High School Biology." Science Education, Vol. 48, No. 5, December, 1964. pp. 447-453.

176. THELEN, L. J. "The Impact of Science Fairs on Student Exhibitors." Science Education, Vol. 48, No. 5, December, 1964. pp. 442-446.

177. THOMPSON, James J. "A New Method of Science Teaching." Science Education, Vol. 48, No. 3, October, 1964. pp. 390-392.

178. TOOHEY, Jack V. "The Comparative Effects of Laboratory and Lecture Methods of Instruction in Earth Science and General Science Classes." Dissertation Abstracts, Vol. XXIV, No. 8, 3241, Order No. 64-2194.

179. TOOHEY, Jack V. "Evaluating Effectiveness of a Linear Programed Course in Science Education." Journal of Research in Science Teaching, Vol. 2, Issue 1, 1964. p. 59.

180. TUBBS, Frederick Barnes. "Some Characteristics of Highly Effective and Less Effective Secondary School Science Teachers." Dissertation Abstracts, Vol. XXIV, No. 11, 4576, Order No. 64-7066.

181. VAN DEVENTER, W. C. "Laboratory-Centered Science Teaching." Metropolitan Detroit Science Review, Vol. XXIV, No. 3, September, 1963. pp. 105-107.

182. VAN DEVENTER, W. C. "Michigan Prepares Project on Junior High Science." The Science Teacher, Vol. 31, No. 7, November, 1964. pp. 29-30.

183. VOSS, Burton E. "An Evaluation of the Chemistry Topics in the BSCS Blue Version." Journal of Research in Science Teaching, Vol. 1, Issue 4, 1963. pp. 352-4.

184. WAGNER, Daniel. "A Plan for a Proposed Course in Natural Science as an Eleventh or Twelfth Grade Elective in the New Rochelle, New York Schools." Dissertation Abstracts, Vol. XXIV, No. 7, 2743, Order No. 64-1508.

185. WALLACE, Wimburn. "The BSCS 1961-62 Evaluation Program - A Statistical Report." BSCS Newsletter 19, September, 1963. pp. 22-4.

186. WASHTON, Nathan S. "Educating the Science Intern Teacher." School Science and Mathematics, Vol. LXIV, No. 6, June, 1964. pp. 488-90.

187. WEISS, Louis. "Chemistry Seminar for High School Seniors." Journal of Chemical Education, Vol. 41, No. 9, September, 1964. p. 485.

188. WHITE, Robert W. "The Relative Effectiveness of a Team Teaching Method in High School Biology Instruction." Dissertation Abstracts, 23: No. 11, 1963. pp. 4271-2.

189. WHITE, Robert W. "How Successful is Team Teaching?" The Science Teacher, Vol. 31, No. 6, October, 1964. pp. 34-37.

190. WHITNEY, Robert C. "A Comprehensive Study of High School Physics Instructional Facilities." Dissertation Abstracts, Vol. XXIV, No. 9, 3616, Order No. 64-3681.

191. WHITNEY, Robert C. "High School Facilities The Science Teacher, Vol. 30, No. 8, December, 1963. pp. 30-1.

192. WOODWARD, Robert L. "The Science Offerings, Enrollments, Facilities and Science Teachers in the Public Secondary Schools of Upstate New York: Fall 1958 and 1961." Dissertation Abstracts, Vol. 25, Part 1, 210, Order No. 64-3688.

193. WYNN, Dan Camp. "Factors Related to Gain and Loss of Scientific Interest During High School."
Dissertation abstracts, Vol. XXIV, No. 11, 4491, Order No. 64-4460.

194. YAGER, Robert E. "A Junior High School Sequence in Science."
School Science and Mathematics, Vol. LXIII, No. 9, December, 1963. pp. 719-25.

195. YAGER, Robert E. "Science Curriculum Revision."
National Association of Secondary School Principals, Vol. 47, No. 283, May, 1963. p. 140.

APPENDIX C

Abstracts Examined for the 1963 - 1965
Review of Research in Science Education
Secondary School Level

S1. ANDERSON, June S. "A Comparative Study of Chemical Educational Material Study and Traditional Chemistry in Terms of Students' Ability to Use Selected Cognitive Processes." Doctoral Research, The Florida State University, August, 1964.

S2. AUSTIN, Anna T. "Team Teaching Approach to Seventh Grade General Science." M.S. Thesis, Central Connecticut State College, July, 1963.

S3. BACUNGAN, Cleofe M. "A College-Preparatory Chemistry Course for Philippine Secondary Schools." Ph.D. Thesis, State University of Iowa, 1963. Dissertation Abstracts, XXIV (May, 1964).

S4. BAILEY, Orris G. "A Comparison of Achievement in the Concepts of Fundamentals of Chemistry of Eleventh-Grade Senior Physical Science Students Taught by Laboratory Versus Enriched Lecture-Demonstration Methods of Instruction. Ed.D. Thesis, The University of Houston, July, 1964.

S5. BEAUMONT, Sydney Othniel. "Determining the Adequacy of the Cambridge School Certificate Examinations in Evaluating the Attainment of Biology Teaching Objectives in Jamaican Schools." Ph.D. Thesis, New York University, 1962. Dissertation Abstracts, XXV, (October, 1964).

*S6. BENNETT, Lloyd M. "Current Practices in Science Teaching in the Junior High Schools in Texas." Faculty Research, Texas Woman's University, March, 1965. Available from author.

*S7. BENSON, Edward and SCHOROW, Mitchell. "Report of Pilot Study of Programed Instruction." Report to District, Nichols Junior High School, Evanston, Illinois, February, 1962.

S8. BITTER, Julius J. and BUELL, Robert R. "Field Trips in High School Science." M.Ed. Thesis, University of Toledo, June, 1964.

S9. BLANCHARD, B. Everard. "Abilities of High-School Freshmen to Engage in Research Work." Lisle Community High School, Lisle, Illinois, June, 1959. Available from Dembar Educational Research Services, Inc. DERS, Box 1605, Madison 1, Wisconsin.

*S10. BLANKENSHIP, Jacob W. "An Analysis of Certain Characteristics of Biology Teachers in Relation to Their Reactions to the BSCS Biology Program." Ph.D. Thesis, The University of Texas, March, 1964.

* Recommended for inclusion in the U.S.O.E. Report.

*S11. BOGEN, Gerald Keith. "An Appraisal of the Traveling Science Demonstration Lecture Program in Oregon and Its Effectiveness as an Agent for In-Service Education." Ed.D. Thesis, University of Oregon, 1963. Dissertation Abstracts, XXV (May, 1964).

*S12. BRAKKEN, Earl. "An Analysis of Some of the Intellectual Factors Operative in PSSC and Conventional Physics." Ph.D. Thesis, Florida State University, August, 1964. Dissertation Abstracts, Ann Arbor, Michigan.

S13. BREUKELMAN, John. "Teaching Combinations of the High School Biology Teachers of Kansas, 1963-1964." State Teachers College, Emporia, Kansas, June, 1964. Available from author.

*S14. BROSIUS, Edward J. "A Comparison of Two Methods of Laboratory Instruction in Tenth-Grade Biology." Ed.D. Thesis, The Pennsylvania State University, March, 1965.

*S15. BRAUND, Robert A, Dr. and HEATH, Robert W, Dr. "A Pilot Study of a Cognitive Restructuring Paradigm." Research Study, University of California, December, 1964. Available from authors.

S16. BROWN, Louis H. "A Survey of the Content of Regents Chemistry Courses Versus Advanced Chemistry Courses in New York State." Ed.D. Thesis, State University of New York at Buffalo, November, 1964.

*S17. BROWN, Walter R. "The Professional Objectives of Experienced Science Teachers." Ph. D. Thesis, The Ohio State University, August, 1964.

S18. BUDGE, Donald M. "Development and Testing of Instructional Materials for an Integrated Chemistry and Physics Course in Secondary Schools." Educational Research, Jordan High School, Sandy, Utah, July, 1964. Utah State Board of Education.

S19. BURNETT, Donald A. "A Reappraisal of the Values and Purposes of Science Fairs." M.S. Thesis, Central Connecticut State College, New Britain, July, 1964.

S20. CASEY, Elmer M. "An Investigation of the Effects of Value Orientation on Ability in Problem Solving of Biology Students." Ed.D. Dissertation, Loyola University, June, 1965.

S21. CHAPMAN, John M. and CALDWELL, Loren L. "A Content Study of Earth Science Courses in Selected Secondary Schools." M.S. Thesis, Northern Illinois University. Science Education, XLVIII, No. 5, (December, 1964), 430-436.

S22. CLEWELL, Willard S, Jr. "A Study of the Effects of Teaching Intermediate Algebra and Chemistry as An Integrated Program in the Eleventh Grade." Ed.D. Thesis, Lehigh University, May, 1964.

S23. COWAN, Paul Jackson. "Development of New Autoinstructional Materials and an Analysis of their Effectiveness in Teaching Modern Physics in the Small High School." Ph.D. Dissertation, The University of Texas, April, 1964.

S24. CRAIG, Robert C. and HOLSBACH, Celestine, Sr. "Utilizing Existing Interests to Develop Others in General Science Classes." Marquette University and Sacred Heart School, February, 1965. School Science and Mathematics, (February, 1965) 120-128.

*S25. COULTER, John C. "The Effectiveness of Inductive Laboratory, Inductive Demonstration, and Deductive Laboratory Instruction in Biology." Ph.D. Thesis, University of Minnesota, August, 1965. Dissertation Abstracts,

*S26. CRUMB, Glenn H. "A Study of Understanding Science Developed in High School Physics." Ph.D. Thesis, University of Nebraska, 1964.

S27. CUSICK, James W. "An Analysis of Chemical Bond Principles in an Experimental Introductory Chemistry Course." Ph.D. Thesis, University of Minnesota, May, 1964.

*S28. DAY, William W. "Physics and Critical Thinking: An Experimental Evaluation of PSSC and Traditional Physics in Six Areas of Critical Thinking While Controlling for Intelligence, Achievement, Course Background, and Mobility by Analyses of Covariance." Ed.D. Thesis, University of Nebraska, March, 1964. University Microfilms, Inc., Ann Arbor, Michigan.

*S29. DESSEL, Norman F. "Prediction of Success in Physics for High Ability Students -- A Small Sample Study." San Diego State College, September, 1963. American Journal of Physics, XXXII, (March, 1964), 197-199.

S30. DOLE, Arthur A. and SHERMAN, Ruth G. "Determinants of the Choice of a Science Program by Ninth Grade Males." University of Hawaii, 1963. Journal of Educational Research, LVIII, 1964, 99-105.

S31. DOUGLAS, Jr., Charles H., Jr. "Comparisons Among the College Careers of Students Who Have Participated in the Sir Alexander Fleming Awards, The Oklahoma High School Institutes, The Oklahoma City Science Fairs, and Selected Oklahoma Physics Classes for the Years of 1956-1962." Ed.D. Dissertation, University of Oklahoma, June, 1965.

S32. DZARA, Frederick Theodore, Sr. "An Investigation of Certain Aspects of the Chemistry Section of the National Science Foundation Summer Institutes Held at the University of Alabama, 1957-1962." Ed.D. Thesis, University of Alabama, 1963. Dissertation Abstracts, XXIV, 1964.

S33. ESTES, Cecilia Slack, Mrs. "Attitudes of Certain Seventh Grade Pupils Toward Science." M.S. Thesis, Central Connecticut State College, April, 1964.

*S34. ETTEN, John F. "What's Wrong with High School Science?" Chicago Teachers College, April, 1965. Science Digest, (May, 1965).

*S35. FAKIER, Edwin Louis. "Measurement Techniques Utilized by Biology Teachers of the White Public Senior High Schools of Louisiana in Assigning Marks." Ed.D. Thesis, Louisiana State University, April, 1964.

*S36. FISK, Franklin Gregory. "Is the National Science Foundation Becoming a New Federal Educational Agency?" Ph.D. Thesis, University of Kansas, 1963. Dissertation Abstracts, XXV, (September, 1964).

S37. FORD, Carl C. and BUELL, Robert R. "Laboratory Block for Study of Fundamental Properties of Blood." M.Ed. Thesis, University of Toledo, August, 1964.

*S38. FOWLER, H. Seymour. "Advanced Biology Courses in Secondary Schools of the Commonwealth." Individual Research, The Pennsylvania State University, June, 1964. Available from author.

S39. FRANKEL, Edward, "A Decade of Advanced Placement Program in Biology." New York Board of Education, 1962.

S40. FUCINI, James F. "Physics Reading Resources of Cromwell High School." M.S. Thesis, Central Connecticut State College, June, 1965.

S41. GALBRAITH, James Biddlecomb. "Specific Concepts of Embryology to be Included in High School Biology As Determined by a Survey of Thirty-six New Jersey Public High School Biology Teachers, Fall, 1963." Research Reports, Montclair State College, 1964.

*S42. GALLAGHER, James J. "Children's Explanations of Selected Physical Phenomena: Initial Appraisal and Modifications After Instruction." Ed.D. Thesis, Harvard University, April, 1965.

S43. GAWE, Roger Barry. "The Number, Content, and Objectives of Outdoor Education Programs Sponsored by the Science Departments Among 113 Northern New Jersey Junior and Senior High Schools, Fall, 1963." Research reports, Montclair State College, 1964.

*S44. GENNARO, Eugene D. "A Comparative Study of Two Methods of Teaching High School Biology: The BSCS Yellow Version and Laboratory Blocks with Collateral Reading." Ph.D. Thesis, University of Wisconsin, August, 1964.

*S45. GEORGE, Kenneth D. "An Experimental Evaluation of BSCS and Conventional Biology by Comparing Their Effect on Critical-Thinking Ability." Ed.D. Thesis, University of Kansas, July, 1964. University Microfilms, Inc.

*S46. GIDDINGS, Morsley G. "Factors Related to Achievement in Junior High School Science in Disadvantaged Areas of New York City." Ed.D. Dissertation, Teachers College, Columbia University, January, 1965.

S47. GITHENS, Jr., Sherwood, "Quantitative Physical Science for the Junior High School." Duke University, unpublished.

*S48. GOMEZ, Severo. "An Evaluation of the Organizational Features and Instructional Methods of the Junior High School Science Program in Selected Texas Schools." Ph.D. Thesis, University of Texas, April, 1965. University Microfilms, Inc.

S49. KAUSCH, Alfred R. "A Unit on Marine Plankton: A Survey of the Inclusion of Marine Planktonology in Biology Courses of Twenty-two Public High Schools, Bergen County, New Jersey, Spring, 1964." Research Report, Montclair State College, 1964.

*S50. HAMILTON, Nancy Barnett. "The Scientific Literacy of Seniors in Urban, Suburban, and Rural High Schools in Kentucky." Ph.D. Dissertation, The Ohio State University, June, 1965.

*S51. HEDGES, William D., Dr.; MACDOUGALL, Mary Ann, Dr.; and LOCHHEAD, Ian Colin. "The Nature and Quality of Teacher-Made Science Tests in Virginia High Schools." Research Project, Division of Educational Research, May, 1964.

S52. HENKEL, Elmer Thomas. "The Relationship of the Kinetic Coefficient of Friction to the Velocity of the Moving Surfaces: A Project for High School Physics." M.Ed. Thesis, University of Toledo, August, 1963.

*S53. HERRON, James Dudley. "A Factor Analytic and Statistical Comparison of CHEM Study and Conventional Chemistry in Terms of their Development of Cognitive Abilities." Ph.D. Thesis, Florida State University, August, 1965. University Microfilms.

*S54. HILL, Casper William. "A Syllabus of A Course in General Biology for the Non-Academic Student in High School." Ed.D. Thesis, New York University, 1963. Dissertation Abstracts, XXIV, (January, 1964.)

S55. HOOVER, Richard J. and BUELL, R.R. "A Study of the Need for Ability Grouping in Science Classes at Springfield Local High School." M.S.Ed. Thesis, University of Toledo, August, 1965.

*S56. HOWE, Robert Wilson. "The Relationship of Learning Outcomes to Selected Teacher Factors and Teaching Methods in Tenth Grade Biology Classes in Oregon." Ed.D. Thesis, Oregon State University, August, 1963. University Microfilms.

*S57. HUBBARD, Howard Newton. "Junior High School Students' Perceptions of Science and Scientists." Ed.D. Thesis, University of California, 1964. Dissertation Abstracts, XXIV, (June, 1964).

S58. HUNSINGER, Carolyn. "Photoperiodism in Flowering Plants: A Teaching Project." University of Toledo, June, 1964.

*S59. HUNT, Edward George. "Team Teaching in Junior High School Science and Social Studies." Ph.D. Thesis, The University of Connecticut, 1963. Dissertation Abstracts, XXIV, (May, 1964).

S60. HURST, Peggy, "Acceleration and the Gifted." Bowling Green State University, 1963. Available from Superintendent of Public Instruction, Ohio's Academically Gifted and Division of Special Education, State of Ohio, Department of Education.

*S61. JERKINS, Kenneth Francis. "An Exploratory Study of Learning and Retention in General Science Classes Utilizing the MPATI Telecast Course 'Investigating the World of Science'." Ph.D. Thesis, Purdue University, 1963. Available from the Midwest Program on Airborne Television Instruction, Lafayette, Indiana.

*S62. JOHNSON, Donald W. "The Effect of Radiation Science Institutes on Secondary Science Programs in California." Contract Research, California State Department of Education, April, 1964. Available from author.

S63. JOHNSON, Norman F. "An Experimental Study with Irradiated Seeds in High School Biology Classes." M.S. Thesis, Central Connecticut State College, June, 1965.

S64. KAUSER, Dennis E. "Semimicro Qualitative Cation Analysis for High Schools." M.Ed. Thesis, University of Toledo, May, 1965. Available from author.

S65. KAY, Richard. "Selected Demonstrations and Activities for High School Biology." M.S. Thesis, University of Utah, August, 1964. Available from author.

*S66. KLEINMAN, Gladys. S., "General Science Teachers' Questions, Pupil and Teacher Behavior, and Pupils' Understanding of Science." Ed.D. Thesis, University of Virginia, July, 1964. University Microfilms, Ann Arbor, Michigan.

S67. KLEPPINGER, Edward Wright. "An Historical and Experimental Approach to the Teaching of Atomic Structure and Sciencing." Ph.D. Dissertation, University of Toledo, June, 1965. Dissertation Abstracts.

S68. KLIMAS, O.S.F., Sister Mary Arsenia. "Sourcebook: The Effects of Mineral Deficiencies on Hydroponically-Grown Bryophytes." University of Toledo, May, 1965.

*S69. KOZAK, Virginia S. "The Development of Earth Science in the Secondary Schools of New York State from 1900-1963." Project, Colgate University, June, 1964. Available from author.

S70. KUEBBELER, Ann E. "A Bibliography of Supplementary Reading for the Biological Sciences Curriculum Study Text: Biological Sciences: Molecules to Man (Blue Version)." M.A. Thesis, University of Toledo, June, 1964.

S71. LANGUIS, Marlin Leroy. "The Role of Observation in the Strategies Employed by American Research Scientists." Ed.D. Thesis, The Pennsylvania State University, August, 1964.

S72. LAUGHLIN, Alice Margaret. "Laboratory Experiments to Demonstrate in Vitro Uptake of Cobalt^{60}-Labeled Vitamin B_{12} by Tissue Slices." Ed.D. Thesis, Columbia University, 1965.

S73. LAZOW, Alfred, Dr. "The Construction of a Junior High Science Achievement Test Based on a Vocabulary Selected from Current Science Textbooks." Ed.D. Thesis, Boston University, June, 1964.

S74. LEONARD, Sidney and BUELL, Robert R. "A Unit for Teaching an Introduction to Scientific Measurement on the 8th Grade Level." M.Ed. Thesis, University of Toledo, June, 1964.

*S75. LINDBECK, Joy S. "A Study of the Effects of Response Made on Programmed Textbook Learning Relative to Atomic Structure." Ed.D. Thesis, University of Pittsburgh, June, 1964. Available from University Microfilms, Inc.

*S76. LISONBEE, Lorenzo K. "The Comparative Effect of BSCS and Traditional Biology Upon Student Achievement." Ed.D. Thesis, [illegible] State University, July, 1963. School Science and Mathematics, XLIV, No. 7, (October, 1964). 594-598. Available from University Microfilms, Inc.

*S77. MAHAN, Luther Alvin. "The Effect of Problem-Solving and Lecture-Discussion Methods of Teaching General Science in Developing Student Growth in Basic Understanding, Problem-Solving Skills, Attitudes, Interests, and Personal Adjustment." Ed.D. Thesis, The Pennsylvania State University, 1963. Dissertation Abstracts, XXIV, (September, 1963).

S78. MATAVA, Noreen K., Mrs. "An Evaluation of a Student Oral Presentation Method in Seventh Grade Science Teaching." M.S. Thesis, Central Connecticut State College, April, 1965.

*S79. MATTHEWS, Charles C. "The Classroom Verbal Behavior of the Secondary School Science Student Teacher and the Cooperating Classroom Teacher." Ph.D. Thesis, Cornell University, July, 1965. Available from author.

*S80. MATTHEWS, William H., III. "Current Status of Earth Science in Secondary Schools." Earth Science Curriculum Project, 1963. Journal of Geological Education, XII, No. 2, (June, 1964). 60-63.

*S81. MCFARLAND, Donald F., Jr. "Implementation of the Chemical Education Material Study in a Large Urban School System." Ed.D. Thesis, Wayne State University, May, 1965. Available from University Microfilms, Inc.

S82. MELLEY, Kenneth F. "Oceanography in a Ninth Grade Earth Science Course." M.S. Thesis, Central Connecticut State College, June, 1965.

*S83. MORGAN, Ashley G., Jr. "An Investigation and Comparison of the Vocabularies, Principles, and Objectives of Textbooks in High School Chemistry and Popular Literature." Ed.D. Dissertation, University of Georgia, August, 1964. Available from University Microfilms, Inc.

*S84. MORHOLT, Evelyn. "The Use of Chlorella To Teach Conceptual Schemes and Experimental Approaches in Biology: A Resource Unit to Illustrate the Use of an Organism as a Focus for the Development of Ideas Central to a Course of Study." Ed.D. Thesis, Columbia University, 1963. Dissertation Abstracts, XXV, (July, 1964).

*S85. MORRIS, Kenneth Turner. "A Comparative Study of Selected Needs, Values, and Motives of Science and Non-Science Teachers." Ed.D. Thesis, University of Georgia, 1963. Dissertation Abstracts, XXIV, (December, 1964).

S86. NAFASH, Robert H. "Construction of A Laboratory Manual for An Advanced Placement Chemistry Course for North Bergen (New Jersey) High School, Based on a Survey of the Experiments Performed During the First-Year Course at Fifty-Seven Colleges and Universities." Research Report, Montclair State College, 1964.

*S87. NAHRSTEDT, Gary Walter. "An Analysis of the Junior High School Science Program, With Proposed Guides for Curriculum Revision." Ed.D. Thesis, Auburn University, 1963. Dissertation Abstracts, XXIV, (February, 1964).

S88. NASCA, Donald. "The Effect of Laboratory Exercises and Programed Materials on the Ability to Solve Problems in Science." Available from author.

S89. PAANANEN, Muriel Marguerite and BUELL, R.R. "Problems in Teaching Evolution in High School Biology." M.S. Thesis, University of Toledo, July, 1965.

*S90. PARASUGO, Paul A. "A Survey of Instructional Programs in Science for Seventh Grade Slow Learners in Ten Selected Essex County Junior High Schools." Research Report, Montclair State College, 1964.

*S91. RATHE, Dale D. "Certain Physics Generalizations Desirable for Students to Attain Before Taking the Physical Science Study Committee's High School Physics Course." Ed.D. Thesis, University of Nebraska, June, 1964. Available from University Microfilms, Inc.

*S92. RIGGSBY, Ernest D. "The Scientific Method As Presented in Science Textbooks and As Described by Eminent Scientists." Ed.D. Thesis, George Peabody College, May, 1964. Available from University Microfilms, Inc.

S93. ROBINSON, James T. "An Investigation of Selected Frameworks of Science." Ed.D. Thesis, Stanford University, April, 1964. Available from University Microfilms, Inc.

*S94. ROBINSON, James T., "Understandings of BSCS Biology Students as Determined by Instructional Tests." Research Project, Los Angeles County Schools Office and Claremont Graduate School, January, 1965.

S95. ROSS, John D. "The Development of an Earth and Space Science Curriculum in the Secondary Schools of Canton, Connecticut." M.S. Thesis, Central Connecticut State College, April, 1964.

S96. SANDERS, Carroll B. and BUELL, R.R. "A Sourcebook of Biological Field Trips in Erie Co., Ohio. M.S. Thesis, University of Toledo, May, 1965.

*S97. SAWYER, Robert Lee. "An Investigation of the Effectiveness of the Program Recommended by the Physical Science Study Committee." Ed.D. Thesis, University of Maryland, 1963. <u>Dissertation Abstracts</u>, XXIV, (June, 1964).

S98. SAWYERS, Milon L. "Current Trends in Teaching Arithmetic and Their Application to Science Education in the Junior High School." M.S. Thesis, University of Toledo, August, 1965.

S99. SCHNELL, Marion F. and BUELL, Robert R. "An Analysis of Newer Science and Mathematics Curriculum Materials." M.Ed. Thesis, University of Toledo, June, 1964.

S100. SEELING, Robert H. "A Study of the College Science Preparation of Idaho High School Biology Teachers for the 1964-65 School Year." M.A.Ed. Thesis, Idaho State University, 1965.

S101. SEIPLE, James E. "An Earth Science Program for Huron High School." M.Ed. Thesis, University of Toledo, July, 1964.

S102. SHAPIRO, Jacob W. "A Method for Utilization of Community Resources for Gifted Science Students in Secondary Schools." Independent Study, George Peabody College for Teachers, April, 1964. Available from author.

S103. SHARKAN, W.W., Dr. "An Evaluation of the Team Organization Plan of Staff Utilization in Relationship to the Educational Development of Students in the Junior High Schools of Allentown, Pennsylvania." Ed.D. Thesis, Pennsylvania State University, August, 1962. Available from author.

S104. SMITH, Philip D., Dr. "Knowledge of Results and Continuity of Various Techniques in Presenting a Filmstrip as Factors in Immediate Learning and Retention." Ed.D. Thesis, Bob Jones University, March, 1964. <u>Audio-Visual Communication Review</u>, Spring, 1965, 106-107. Library of Congress (University Microfilms, Inc.)

S105. SPACKEY, Edwin L. and BUELL, Robert R. "35mm. Close-Up Color Photographs of the Frog and Related Amphibians for High School Biology." M.Ed. Thesis, University of Toledo, 1964.

S106. STODDARD, Charles E., Jr. "A Selected Bibliography of Biological Science for the Secondary School." M.S. Thesis, Central Connecticut State College, March, 1965.

*S107. STOKES, William Woods. "An Analysis and Evaluation of Current Efforts to Improve the Curriculum by Emphasis on Disciplinary Structure and Learning by Discovery." Ed.D. Thesis, The University of Florida, 1963. <u>Dissertation Abstracts</u>, XXV, (July, 1964).

S108. STREHLE, Joseph Albert. "The Comparative Achievement of Seventh-Grade Exploratory Science Students Taught by Laboratory Versus Enriched Lecture-Demonstration Methods of Instruction." Ed.D. Thesis, University of Houston, 1964. <u>Dissertation Abstracts</u>, XXV, (October, 1964).

S109. SUTMAN, Frank X. "A Modified Team Approach in Teaching Two Units of Seventh Grade General Science." Research, Temple University, February, 1965. In Press, Journal of Research in Science Teaching, III.

S110. THATCHER, Rita Diehl and BUELL, Robert R. "Behavioral Responses of Fishes Under Certain Varied Environmental Conditions: A Sourcebook for Teachers." Project, University of Toledo, 1964.

S111. TOOHEY, Jack Vincent. "The Comparative Effects of Laboratory and Lecture Methods of Instruction in Earth Science and General Science Classes." Ed.D. Thesis, Arizona State University, 1963. Dissertation Abstracts, XXIV, (February, 1964).

*S112. TUBBS, Frederick B. "Some Characteristics of Highly Effective and Less Effective Secondary-School Science Teachers." Ph.D. Thesis, The Ohio State University, November, 1963. Available from University Microfilms, Inc.

*S113. VANHOUTEN, William J. "Laboratory and Demonstration Skills Needed to Teach Physics and Chemistry in the Secondary Schools: A Checklist and Suggested System for the Development of these Skills." Ed.D. Thesis, Teachers College, Columbia University, May, 1965. Available from University Microfilms, Inc.

S114. VITROGAN, David. "The Development of a Course of Study in Space Science Suitable for Instruction in the Ninth and Tenth Grades in the Secondary School." Grant, Pratt Institute, June, 1964. Available from Special Projects in Science Education and National Aeronautics and Space Administration.

*S115. ____________. "The Development of a Scale to Measure a Generalized Attitude of Secondary School Students Toward Science." Ph.D. Thesis, New York University, June, 1965.

*S116. VOSS, Burton E. "An Evaluation of the Chemistry Topics in the BSCS Blue Version." Research, The Pennsylvania State University, October, 1963. Journal of Research in Science Teaching, (Issue 4, 1963).

S117. WAGNER, Daniel. "A Plan for a Proposed Course in Natural Science as an Eleventh or Twelfth Grade Elective in the New Rochelle, New York Schools." Ed.D. Thesis, Columbia University, 1963. Dissertation Abstracts, XXIV, (January, 1964).

*S118. WARD, Harold Eugene. "Special Institute Science Courses in Academic Year Institutes, 1962-63." Ph.D. Thesis, The Ohio State University, 1964. Dissertation Abstracts, XXV, (August, 1964).

S119. WATKINS, Marilyn Mauck. "Academic Preparation in Science of Chemistry Teachers in the Kansas High Schools, 1962-1963." Master's Report, School of Education, Kansas State University, 1963.

* S120. WEISBERG, Joseph. "Teacher and Administration Attitudes Toward the Value and Control of Science Projects in New Jersey Secondary Schools." Research Report, Montclair State College, 1964.

S121. WICK, John William. "An Investigation of the Effectiveness of Three Presentations of Eighth Grade Biology." Special Research, University of Iowa, 1965. Unpublished.

* S122. WOODARD, Robert L. "The Science Offerings, Enrollments, Facilities, and Science Teachers in the Public Secondary Schools of Upstate New York: Fall 1958 and 1961." Ph.D. Thesis, Cornell University, September, 1963.

* S123. WYNN, Dan Camp. "Factors Related To Gain and Loss of Scientific Interest During High School." Ed.D. Thesis, University of Georgia, 1963. Dissertation Abstracts, XXIV, (May, 1964).

* S124. ZAKI, W.M., Dr. "The Attitudes of Pakistani Science Teachers Towards Religion and Science." Ed.D. Thesis, Harvard University, April, 1964. Unpublished.

S125. ZIMMER, William Wolf. "The Qualifications of Forty-nine High School Physics Teachers in Bergen, Essex, and Passaic Counties, New Jersey." Research Report, Montclair State College, 1964.