A STUDY OF SCIENCE ACHIEVEMENT IN THE SEVENTH AND EIGHTH GRADES OF THE HALSTEAD ELEMENTARY SCHOOL, HALSTEAD, KANSAS, 1965-1968

by

WILLARD GEORGE EBERSOLE

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THE PROBLEM AND DESIGN OF THE STUDY

Much needed improvement has been taking place in science curricula in recent years. At the high school level newly developed programs in chemistry, biology, and physics have greatly improved the curriculum. With the impetus provided by the work at the high school level, elementary school science projects are providing the necessary means for improving the curriculum and instruction at the elementary level.

More recently considerable attention is being given to the junior high school science curriculum and much work has already been done to try to fill the gap in the total science curriculum. Studies and conferences have been and are being sponsored by various organizations.[1] Professional groups have been examining general science programs.[2] Special projects, such as the Princeton Project or the Earth Science Curriculum Project, were formed to develop new materials, and some of these are now in regular textbook form[3] for use in junior high schools. Textbook companies are developing various new programs with changes and improvements reflecting the new ideas and thinking emerging from the boiling caldron of work and ideas for the improvement of junior high science.

As these new programs are being developed and new materials prepared there is a continuous need for evaluation. Some evaluation was

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[1]John R. Mayor, "The Critical Role of Junior High School Science," Journal of Secondary Education, 39:201-204, May, 1964.

[2]Sam S. Blanc, "New Directions in Junior High School Science," School Science and Mathematics, 54:282-284, April, 1964.

[3]Earth Science Curriculum Project, Investigating the Earth (Boston: Houghton Mifflin Company, 1967).

and is done during the preparation of materials,[4] and, hopefully, more will be done as the materials are used in the classroom just as was done with the high school materials.

The Problem

Statement of the problem. The purposes of this study were (1) to make a statistical study of the science achievement in the seventh and eighth grades of the Halstead Elementary School for the scholastic years 1965-66 through 1967-68; and (2) to determine what significance, if any, the results may have for the improvement of the science program in the Halstead Elementary School.

The specific factors considered in the study were (1) the mean achievement in science for each grade from year to year; and (2) science achievement in relation to each of the following: reading achievement, arithmetic achievement, sex, and mental ability.

Significance of the study. The inadequacy of traditional science is well-recognized,[5] and a variety of programs are being tried and used in the hope of improvement. In 1967 the Halstead Elementary School changed from a traditional general science type program in the seventh and eighth grades to a sequential type program. The change was brought about by the

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[4] Ibid., p. vii; John Gabriel Navarra, Joseph Zafforoni and John Edward Garone, Life and the Molecule: The Biological Sciences (Evanston: Harper & Row, Publishers, 1966), p. v.

[5] Robert H. Carleton, "Science Education in the Middle or Junior High School Grades," The Science Teacher, 34:25, December, 1967.

adoption of a life science text in the seventh grade and an earth science text in the eighth grade. The intent and hope was for improvement. Time will tell, perhaps, if such was the case, but only as some type of evaluation is done. This study is a beginning step in the process of evaluation and should provide information and ideas on which to base decisions concerning further changes in the science curriculum in Halstead and in other schools with similar programs.

Definitions of Terms Used

Elementary school. Usually, it includes grades K through six; however, Halstead has an eight-four administrative design.

Junior high grades. Generally, the term refers to grades seven, eight, and nine. In reference to Halstead the term refers to grades seven and eight which operate under a departmentalized program within the elementary school.

Achievement. The performance of students as measured by the Stanford Achievement Test, Advanced Battery.[6]

Science Achievement. This is achievement as measured by the Science subtest of the Stanford Achievement Test.

Reading Achievement. Achievement as measured by the Paragraph Meaning subtest of the Stanford Achievement Test is reading achievement. No vocabulary test is included in the advanced battery since vocabulary and paragraph meaning are so closely related at the junior high level.[7]

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[6]Truman L. Kelley and others, Stanford Achievement Test; Advanced Battery for Grades 7, 8 and 9 (New York: Harcourt, Brace & World, Inc., 1964).

[7]Ibid., Directions for Administering, p. 4.

Arithmetic achievement. Arithmetic achievement is measured by three subtests of the Stanford Achievement Test--Arithmetic Computation, Arithmetic Concepts, and Arithmetic Applications.

Mental ability. The performance of students on the scholastic aptitude section (Verbal Reasoning plus Numerical Ability) of the Differential Aptitude Tests[8] or the performance on the California Short-Form Test of Mental Maturity[9] is referred to as mental ability.

Traditional science. General science with the topic-by-topic, spiral type organization is traditional science. In reference to the Halstead school it refers to the ABC Science Series; Advantures in Science for the seventh grade, and Broadening Worlds of Science for the eighth grade.[10]

Sequential science. This is science organized around various disciplines or broad fields of study such as the life, earth, and physical sciences. The sequence now used in Halstead has life science in the seventh grade using the text The World of Living Things,[11] and earth science in the eighth grade using the text Investigating the Earth.[12]

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[8]George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, Differential Aptitude Tests, Form L and Manual, Fourth Edition (New York: The Psychological Corporation, 1963 and 1966.

[9]Elizabeth T. Sullivan, Willis W. Clark and Earnest W. Tiegs, California Short-Form Test of Mental Maturity (Monterey: California Test Bureau, 1963).

[10]William J. Jacobson, Robert N. King, and Louise E. Killie, ABC Science Series: Adventures in Science and Broadening Worlds of Science (New York: American Book Company, 1959).

[11]Paul F. Brandwein and others, The World of Living Things (New York: Harcourt, Brace & World, Inc., 1964).

[12]Earth Science Curriculum Project, op. cit.

Stanines. The word "stanine" was originally derived from "STAndard NINE-point scale." The term refers to the intervals in a scale in which raw scores are converted to scores which range from 1 (low) to 9 (high) with a mean of five and a standard deviation of two.[13]

Design and Limitations of the Study

A descriptive study was made of the seventh and eighth grade science program of the Halstead Elementary School covering the school years 1965-66 through 1967-68. The study was primarily a statistical study of the achievement of students in science. Data for the study were compiled from the student records and files in the office of the Halstead Elementary School. The study was limited to those students for which there were complete sets of data on achievement and mental ability. As shown in Table I, page 20, this included 93.9 percent of the students enrolled in science during the three year period.

Statistical procedures used in carrying out the study were:

1. Frequency distributions of the achievement scores were made for each of the six classes and revealed that the groups were not normally distributed, most being considerably skewed and some even multimodal.

2. A nonparametric one-way analysis of variance, the Kruskal-Wallis One-Way Analysis of Variance by Ranks,[14] was done since the groups were

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[13] Walter N. Durost, The Characteristics, Uses, and Computations of Stanines, Test Service Notebook, Number 23 (New York : Harcourt, Brace & World, Inc. 1961), p. 1.

[14] Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Company, Inc., 1956), pp. 184-8.

found not to be normally distributed. This was followed by an analysis of variance and an F test.[15]

3. Since the data did not fit the basic assumption of normality for correlation coefficients,[16] it was decided to use the chi square test in contingency tables.[17] Consequently, all data were put in terms of stanine scores. Stanine scores for the Stanford Achievement Test and the California Short-Form Test of Mental Maturity were included in the student records. The DAT scores were converted to stanine scores according to information given in the DAT manual.[18] Data were then punched on cards and processed by computor in the Kansas State University Computer Center.

4. Measures of central value, mean and median, and of dispersion, standard deviation and range, were also determined for use as descriptive techniques.

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[15] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Company, 1965), pp. 278-81.

[16] Ibid., pp. 107-8.

[17] Ibid., pp. 234-36.

[18] Bennett, Seashore, and Wesman, op. cit., p. 3-2.

REVIEW OF THE LITERATURE

The review of the literature revealed that the major concerns to which persons involved in junior high science have been addressing themselves are (1) the inadequacy of traditional general science, (2) the importance of junior high science in the total science curriculum, (3) the development of new programs, and (4) the need for continued evaluation and research.

Inadequacy of Traditional General Science

The literature covering the last seven or eight years is abundant with articles either speaking about or making reference to the inadequacy of general science as it has been taught for the last several decades. The general feeling of persons involved in junior high science was expressed by Montag when she wrote that "producing a vital, exciting and interesting course in general science has been, and still is, one of the most frustrating problems high school science departments face," and described general science as "a hodgepodge of isolated facts in all the physical and biological sciences."[19] Others have spoken of general science as being "sick . . . needing the 'miracle drug' of re-evaluation to reclaim it,"[20] and as a "pause in the curriculum"[21] between exploratory

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[19] Betty Jo Montag, "Renovating General Science," *Journal of Secondary Education*, 39:109, March, 1964.

[20] John W. Renner, "Junior High School Science Picture," *The American School Board Journal*, 143:15, November, 1961.

[21] Harold P. Pluimer, "Let's Teach Science in the Junior High," *Minnesota Journal of Education*, 44:15, February, 1964.

elementary science and the laboratory courses in high school.

A variety of factors have contributed to the pause or lag in general science and its inappropriate curriculum. Renner identifies the following three factors:

1. A science course to be a true scientific experience must be not only "talking" science but also "doing" science. The lecture-demonstration method has replaced to a large extent the individual laboratory experience because it is a lot cheaper. As a result the experience side of science was ignored.

2. The concept of general science has fallen into disfavor because of the nature of the course itself. Areas of science from which general science draws its content have been taught too independently with little teaching of the interdisciplinary relationships which exist. Scientists must have basic understandings of all the sciences and see the relationships that exist among them.

3. Teachers must know the interdisciplinary relationships among the sciences in order to be able to teach them; therefore, teacher training must change.[22]

Traditional general science has been inadequate, suggests Carleton, because of the almost total emphasis on description, utilitarian uses, technology, and memorization, with little or no laboratory work for pupils; and because of poorly prepared teachers and a high turnover among teachers.

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[22]John W. Renner, "Why Change Science Teaching?" School Science and Mathematics, 54:412-20, May, 1964.

He emphasizes the disparity of traditional general science by saying:

> Serious analysts and critics allege that traditional general science has tended to kill off rather than nurture children's interests in things scientific and further study in science, that it has done little or nothing to advance scientific literacy widely among the total population, and that it has failed to present science as one of man's humanistic endeavors and to differentiate between science and technology.[23]

In his doctoral dissertation, Paparello notes that problems responsible for current criticisms of junior high school science center on lack of commitment of teachers and administrators, uncertainties relating to objectives and content, need of improved instructional facilities, and lack of "prestige" at junior high school teaching level.[24]

The faults and problems of general science were listed by Heimler as:

1. Courses attempt to cover too much content information---skimming over many topics at each grade level.

2. Emphasis almost solely on recall of facts rather than the development of concepts, and understandings.

3. Classes have been too large and teachers generally poorly prepared in science. Many general science teachers who have split loads do not have prime interest in the teaching of science. He cites an article by Dr. Mallinson in the October, 1963, issue of School Science and Mathematics which noted that a tentative finding of the Science Motivation

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[23]Carleton, *loc. cit.*

[24]Frank N. Paparello, "Junior High School Science; Guidelines for Curriculum Improvement," *Dissertation Abstracts*, 27:2925-6-A, March, 1967.

Project is that unqualified teachers may actually reduce student performance.

4. Much technology has been included as science. Science and technology are separate and distinct--interrelated, but certainly not the same.

5. Space, equipment, and facilities have not been adequate, usually not, for an activity-centered program.

6. Where schools have had strong elementary science programs, general science has become repetitious of what is taught and done in the lower grades.[25]

In an earlier article Heimler suggested that lack of adequate time for instruction in general science has also been a problem.[26]

The ensuing problem of repetition mentioned in six above was noted already in 1953 by Mallinson and Buck who said that repetition of topics in general science in junior high has proved to be deadening to the students.[27] The spiraling concept approach used in many science textbooks series was no doubt based on the idea that repetition strengthens learning and that you start with the familiar and add to it. While some repetition is desirable or necessary, repetition without increasing the sophistication of the experiment leads to boredom and an attitude of "we know that already".[28]

25Charles H. Heimler, "General Science in a State of Flux," School Science and Mathematics, 64:757-58, December, 1964.

26Heimler, "General Science; A Reorganization of the Basic Course," The Clearing House, 36:456, April, 1962.

27George G. Mallinson and Jacqueline V. Buck, "The Coming of General Physical Science," The Clearing House, 28:160, November, 1953.

28National Science Teachers Association, Quality Science for Secondary Schools (Washington, D.C.: National Science Teachers Association, 1960), p. 70; Frank J. Kovak, Jr., "Junior High School Science for Today and Tomorrow," The Bulletin of the National Association of Secondary School Principals, 47:26-33, December, 1963.

More articles could be cited concerning the shortcomings and inadequacies of traditional general science, but, as Simendinger pointed out, by 1960 it became imperative that major revisions be made in junior high science.[29]

Importance of Junior High Science

As noted earlier, Paparello pointed out the lack of commitment on the part of teachers and administrators to general science programs. This seems to indicate that the importance of general science in the junior high has not been sufficiently recognized.

Citing Heimler again, "What we must recognize, and this to me is the crux of the situation, is that science in grades seven, eight, and nine whether it be general or otherwise, is of vital significance in the education of our future citizens--both scientists and non-scientists alike."[30] He notes that on a national scale, eighty-five percent of high school students elect a course in biology, whereas only thirty-five percent elect a high school course in physical science, chemistry, or physics. This means that sixty-five percent of today's students receive the great bulk of their schooling in the physical sciences in grades seven, eight, and nine. Of further note is the fact that science talented students

[29]Elizabeth A. Simendinger, "Curriculum Revision in Science," The Science Teacher, 30:28, March, 1963.

[30]Heimler, "General Science in a State of Flux," School Science and Mathematics, 64:758-9, December, 1964.

often identify a career interest in science while studying general science. Students who experience a rich, rewarding study of general science in the junior high school or upper elementary grades are more likely to elect the high school sciences later on than those students who have an unpleasant experience in general science.[31]

Another important consideration for junior high science is that many students are not college-bound and that science in the junior high may well represent the last formal contact with the physical sciences.[32]

Some final considerations for the importance of science in the junior high are that in the junior high school foundations may be laid for the high school sciences--biology, physics, chemistry--and, that the schools can help solve some of the essential problems of delinquency by channeling constructively the restless energy of students through a more active and absorbing curriculum of which science should be an important part.[33]

Development of New Programs

Much has been and is still being done to try to overcome the shortcomings of general science in junior high school. Many new ideas and

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[31] Ibid.; Abraham S. Fischler, Modern Junior High School Science, (New York: Bureau of Publications, Teachers College, Columbia University, 1961), p. 3.

[32] Fischler, loc. cit.

[33] Victoria Wagner, "Crisis in Education: Science and Human Values," Science Education, 46:99-105, March, 1962; Navarra, Zafforoni, and Garone, loc. cit.

innovations have arisen resulting in considerable confusion at times with little agreement as to what to teach, to what depth to teach, and how to teach adolescents the meaning of science and to show the impact of science on everyday living.[34]

Although opinions and ideas have been quite variant as to what approaches to use there are some points of agreement. Considerable agreement has been evidenced that by the very nature of science it must be laboratory-centered (investigatory) regardless whether the course uses the disciplinary approach or the interdisciplinary approach. Consequently, meaningful laboratory experiences must be developed and adequate laboratory materials be provided.[35] There is disagreement, however, as to the need for a formal laboratory, for a study completed in 1962 concerning the use of laboratories in junior high science indicated that the use of laboratories in junior high science instruction made no significant difference in achievement and that further consideration needs to be given before public schools invest large sums of money for junior high school laboratories.[36] Programs and materials are available which allow for experimentation and investigation without a formal laboratory.

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[34]Samuel W. Bloom, "Strengthening the Junior High School Science Program," The Science Teacher, 30:18, November, 1963.

[35]John S. Richardson, "Evaluating a High School Science Program," The North Central Association Quarterly, 41:194, Fall, 1966; John R. Mayor, "The Critical Role of Junior High Science," Journal of Secondary Education, 39:201-204, May, 1964; John W. Renner, "Junior High School Science Picture," The American School Board Journal, 143:15, November, 1961; Harold P. Pluimer, "Let's Teach Science in the Junior High," Minnesota Journal of Education, 44:15-16, February, 1964.

[36]Alan H. Humphreys, "A Critical Analysis of the Use of Laboratories and Consultants in Junior High School Science Courses," Dissertation Abstracts, 23:1623, 1962.

Another point of agreement among science educators is shown in the general tendency or trend to have courses cover less material than before but in greater depth.[37] Along with this depth coverage the interrelatedness of the various disciplines should be emphasized.

One of the general guidelines arising out of the work of the professional groups examining general science programs was that general science courses should become more unified with courses at each grade level organized around a central theme. Concern should be with development of basic understandings related to the unifying theme that runs as a thread through the entire year's work.[38]

The major difference of opinion has been on what approach junior high science courses should involve. Carleton identifies three principal kinds of middle or junior high school science courses according to the approach used: (1) discipline-centered, (2) concept-centered and disciplinary, and (3) process-centered (with a tendency toward discipline orientation but no major effort to "survey" an entire field). These divisions do not represent watertight compartments, however.[39]

The organizational pattern for textbooks series or courses using the disciplinary approach is usually life science, earth science, and physical science, but the sequence may vary. Several studies seem to indicate that the most desirable sequence is the one mentioned, starting

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[37]Albert F. Eiss, "Teaching Junior High School Science: I Believe in a Specialized Approach," NEA Journal, 52:56, October, 1963.

[38]Sam S. Blanc, "New Directions in Junior High School Science," School Science and Mathematics, 54:282-4, April, 1964.

[39]Carleton, op. cit., p. 27.

with life science in the seventh grade and continuing through physical science in the ninth grade.[40] Other reports show that the important factor is not necessarily the sequence or the approach, but that courses which emphasize broad concepts and the interrelationships among the sciences, and treat topics in depth will result in increased enthusiasm, better achievement, more interest in high school science electives, and better attitudes on the part of teachers and students.[41]

A review of current textbooks also reflects the fact that no one approach or organizational pattern has been shown to be superior to the others. Some companies have published two or more series, each based on a different approach or using a different organizational pattern. In most cases both series are authored by the same persons.[42] Two textbooks, each published by different companies and based on single but different disciplines, which stressed the experimental nature of science, the interrelationships among the disciplines, and the extensive use of laboratory investigations were judged to be the best junior high science curricula

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[40]James Milton Brown, "An Analysis of Selected Junior High School Science Textbooks," Dissertation Abstracts, 28:2882-4-A, 1968; N. Eldred Bingham, "Working Cooperatively, Science Teachers, Scientists, and Science Educators Produce a Program which Significantly Improves Achievement in Science in the Junior High Schools of Hillsborough County, Florida," Science Education, 47:223, April, 1963.

[41]Richard L. Sweeney, "Small School System Revises and Improves Science Program," The Science Teacher, 33:47-48, October, 1966; Robert E. Yager, "Junior High School Sequence in Science," School Science and Mathematics, 63:719-25, December, 1963.

[42]Helen D. MacCracken and others, Singer Science Series: Basic Life Science, Basic Earth Science, Basic Physical Science; and Singer Science Series: Scientists at Work, Scientists Solve Problems, Scientists Explore (Syracuse: The L. W. Singer Company, Inc., 1964, 1966); Walter A. Thurber and Robert E. Kilburn, Exploring Life Science, Exploring Earth Science, and Exploring Physical Science; and Exploring Science Series: Seven, Eight, and Nine (Boston: Allyn and Bacon, Inc., 1966)

devised to date even though they each have some weaknesses.[43]

What then determines the success or worth of junior high science courses? Fischler feels that it is not the organization that determines the worth of the program but the method of teaching, the best method being the one which presents science as a method of inquiry.[44] The most successful, says another writer, will be those that result in a school system where there is K through 12 planning of science and other curricula.[45] Some significant problems to be considered and kept in mind while planning and developing an effective (successful) junior high science program are given by Marean and Ledbetter:

1. Children in early adolescence possess such variations of interest, talent, and academic ability that no single treatment of any one body of scientific knowledge is likely to be successful with more than 50 percent of the students for an extended period of study.

2. The evolutionary nature of scientific knowledge makes the content of formal science instruction subject to frequent and revolutionary change.

3. There is an increasing need for general education science learning on the part of all youth. It may serve to influence career choices and contribute to the intelligent exercise of the rights and obligations

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[43]Horace MacMahan, Jr. "Princeton Project or ESCP: A Difficult Choice," School Science and Mathematics, 66:87, January, 1966.

[44]Abraham S. Fischler, "Junior High School Science," School Science and Mathematics, 64:29, January 1964.

[45]Joseph D. Novak, "Science in the Junior High School," School Science and Mathematics, 61:701, December, 1961.

of adult citizenship which these individuals will face in a few short years.

Programs have sometimes failed, they suggest, because of losing sight of at least one of these problems.[46]

Need For Continued Evaluation and Research

Mention was made in the previous section of the fact that some evaluation of new curricula is going on and references cited concerning this. Continued evaluation is a pressing responsibility of many in the profession--teachers, administrators, and program designers. The development of these so-called "new curricula" in science also poses the urgent need of research as to their adequacy, their relations to other parts of school science programs, etc.[47]

In the judgement of Carleton, some of the current crop of textbooks are no better than the old general science despite the glowing claims. There's too much of the artificial, the impractical, and too much barren busy-work. In his opinion the primary responsibility of assessing the efficacy of instructional programs and materials rests with the classroom teachers, the supervisors and inspectors, and other responsible school authorities. Evaluation must be seen as an integral part of instruction

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[46]John Marean and Elaine Ledbetter, "A New Approach to Ninth-Grade Science," The Science Teacher, 33:18-20, April, 1966.

[47]John S. Richardson, "Evaluating a High School Science Program," The North Central Association Quarterly, 41:192-203, Fall, 1966.

and of the curriculum itself and not be regarded as something apart.[48]

Educational innovations are seldom evaluated on a systematic basis. The reasons, suggests Walker, are that there are few criteria of educational effectiveness, that it requires controlled conditions for a relatively long time, that it is expensive, and that it might prove negative. But evaluation is absolutely essential if the innovation is to be effective.[49]

Although there has been rapid progress in science education and in the development of science courses and materials in the last decade, there has been little attention and practically no resources devoted to research in science education. Indications are that there has been a decline in the amount of research in science education, probably due to the amount of attention and energy devoted to improving course content and the development of instructional materials. A satisfactory research program needs to be developed to gather and evaluate data concerning the extent of the use and effectiveness of new science courses.[50] Perhaps this could be done by the NSTA along with other jobs that it should undertake such as the development of some evaluative instruments to determine results of science teaching.[51]

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[48]Carleton, op. cit., p. 28.

[49]Noojin Walker, "Innovations in Science: Do We Dance to the Piper's Tune?" The Clearing House, 41:529-32, May, 1967.

[50]Willard J. Jacobson, "Science Education Under Challenge," Teachers College Record, 65:627-34, April, 1964.

[51]Sami I. Boulos, "NSTA Responsibility in Curriculum Development in Science," The Science Teacher, 30:68, September, 1963.

PRESENTATION AND ANALYSIS OF DATA

The Sample

Presented in Table I, page 20, is a distribution of the sample according to class, sex, and grade. There were 134 students in the three seventh grade classes, the largest class having 52 students and the smallest class having 38 students. This was 89.3 percent of the students enrolled in the seventh grade. Taken as a whole the three sample classes were quite evenly divided sexwise, with 68 boys and 66 girls. Individual classes exhibited considerable differences with one class having a 17 to 27 ratio in favor of the girls and another class having a 15 to 23 ratio in favor of the boys.

The three eighth grade classes had a total of 161 students included in the sample, or 98.1 percent of the students enrolled. Sexwise, the three eighth grade classes were not as evenly divided as were the seventh grades, the boys outnumbering the girls 86 to 75. Considerable differences also existed in the sex ratio for the individual eighth grade classes.

The total sample included 295 students which was 93.9 percent of the students enrolled in the seventh and eighth grades for the three-year period. Of this number, 154 were boys and 141 were girls.

Measures of Central Value and Dispersion

Summarized in Table II, page 21, are data on the science achievement test scores. Two measures of central value, the mean and the median, are shown, and two measures of dispersion, the standard deviation and the range, are shown. In light of one of the main purposes of this study,

TABLE I

DISTRIBUTION OF SAMPLE BY CLASS, SEX, AND GRADE

Class	Boys N	Boys %*	Girls N	Girls %*	Total N	Total %*
Seventh, '65-'66	17	94.4	27	90.0	44	91.6
Seventh, '66-'67	23	100.0	15	93.7	38	97.4
Seventh, '67-'68	28	82.3	24	82.7	52	82.5
Total Seventh	68	90.6	66	88.0	134	89.3
Eighth, '65-'66	37	97.3	24	100.0	61	98.3
Eighth, '66-'67	18	100.0	29	96.6	47	97.9
Eighth, '67-'68	31	96.8	22	100.0	53	98.1
Total Eighth	86	97.7	75	98.6	161	98.1
Sample Total	154	94.4	141	93.3	295	93.9

*Percent of students enrolled.

TABLE II

DISTRIBUTIONS OF THE STANFORD SCIENCE ACHIEVEMENT TEST SCORES FOR THE SIX CLASSES

Class	Mean Boys	Mean Girls	Mean Total	Medial Boys	Medial Girls	Medial Total
Seventh, '65-'66	10.46	9.59	9.93	11.18	10.18	10.25
Seventh, '66-'67	9.46	9.35	9.41	10.18	10.00	10.10
Seventh, '67-'68	9.34	8.96	9.17	9.60	9.40	9.60
Eighth, '65-'66	10.40	10.08	10.28	11.24	10.50	10.80
Eighth, '66-'67	10.60	10.08	10.29	10.90	10.43	10.65
Eighth, '67-'68	10.08	9.23	9.73	10.80	10.50	10.77

Class	Standard Deviation Boys	Standard Deviation Girls	Standard Deviation Total	Range Boys	Range Girls	Range Total
Seventh, '65-'66	1.76	1.82	1.85	7.2-12.7	5.2-12.2	5.2-12.7
Seventh, '66-'67	2.54	2.20	2.41	4.7-12.4	3.8-11.7	3.8-12.4
Seventh, '67-'68	1.94	2.04	1.98	5.4-12.4	4.4-11.8	4.4-12.4
Eighth, '65-'66	2.30	1.30	1.97	4.0-12.9	7.5-12.1	4.0-12.9
Eighth, '66-'67	1.35	1.92	1.74	7.6-12.1	5.2-12.4	5.2-12.4
Eighth, '67-'68	2.41	2.63	2.57	3.6-12.9	4.6-11.9	3.6-12.9

which was to note any changes in class achievement, the table reveals that the seventh grade class, '67-'68, had the lowest mean score of the seventh grade classes and the eighth grade class, '67-'68, had the lowest mean score of the three eighth grade classes. The difference in each grade between the highest and the lowest mean score was less than one-half grade point. As will be shown in the next section, this difference among means was found not to be significant.

In all classes, the mean score for the boys was higher than the girls. This is contrary to what has been reported in a number of articles concerning sex and achievement. Sexton reported, "In vastly disproportionate numbers, boys are the maladjusted, the low achievers, the truants, the delinquents, the inattentive, the rebellious."[52] If the writer was inferring by his statement that boys tend to rank the lowest in achievement, that does not hold true in this study either, for an examination of the ranges in Table II shows that the girls had the lowest score in four out of the six classes. Others reporting findings favoring the girls were Corliss,[53] Wisenthal,[54] and Hoedel.[55]

It is notable that mean scores in all cases were considerably higher

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[52]Patricia C. Sexton, "Schools Are Emasculating Our Boys," The Education Digest, 31:32, November, 1965.

[53]William S. Corliss, "Relationships in Achievement by Sex and Number of Children in Family," Michigan Educational Journal, 42:28-9, October, 1964.

[54]Miles Wisenthal, "Sex Differences in Attitudes and Attainment in Junior Schools," The British Journal of Educational Psychology, 35:79-85, February, 1965.

[55]Sister M. Celestine Hoedel, "Adolescent Sex Differences and Secondary Education," Journal of Secondary Education, 40:361-8, December, 1965.

than the population norms which were 7.5 and 8.5 for the two grades respectively.[56] A further observation of note is that in all cases the total means are lower than the total medians, indicative of negative skewing. One explanation for this may be a lack of motivation on the part of the higher-ability students. Another factor which probably enters in is that all grade scores above 9.6 on the achievement test used were extrapolated scores and do not provide the same measure of departure from actual grade status in the same sense as do the scores in the lower part of the scale.[57]

Using the tables from the Directions for Scoring giving stanines and selected percentile ranks corresponding to grade scores,[58] and the definition of stanine, one can estimate the standard deviation of the scores from the population norm to be about 2.5. A check of Table II reveals that all the standard deviations are equal to or smaller than the above estimate for the population. One would expect this to be true. Unexpectedly, there are five cases where the standard deviation for a sex group is larger than the standard deviation for the total class.

Analysis of Variance

As was stated earlier, frequency distributions for the various classes revealed that the classes were not normally distributed. Consequently, a nonparametric one-way analysis of variance was employed. This

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[56] Truman L. Kelley and others, Stanford Achievement Test, Directions for Administering, Advanced Battery (New York: Harcourt, Brace & World, Inc., 1964), p. 16.

[57] Ibid.

[58] Ibid., pp. 18-19.

was then followed by the parametric one-way analysis of variance and an F test. The results of these two tests are set forth in Table III, page 25. On the nonparametric test for the seventh grade, the calculated H/W value was 3.5917, and for the eighth grade, it was .2406. Neither of these values was close to the value necessary for significance at the .05 level. The nature of the results was the same on the parametric test with neither value being close to the value needed to be significant.

If one would reason that if new curricula in science are superior to the old, one could hypothesize that they should result in higher achievement. On the basis of the data shown in Table III, one would have to reject such as hypothesis. No significant change was noted in achievement from the use of the new science texts in 1967-68. Before this conclusion is accepted as valid and any further conclusions are drawn about the effectiveness of the new science texts involved in this study, there are some other factors that need to be considered. These will be pointed out and discussed in a later section.

Chi Square in Contingency Tables

By the use of contingency tables and chi squares, science achievement was compared with achievement in reading, arithmetic computation, arithmetic concepts, arithmetic applications, sex, and mental ability. Data showing the results of these comparisons are shown in Table IV, pages 26 and 27. The results showed significant relationships in all cases except science vs. sex. In the first comparison, science vs. reading, all X^2 values were significant beyond the .05 level, with all but two being

TABLE III

RESULTS OF THE ONE-WAY ANALYSIS OF VARIANCE TESTS
ON SCIENCE ACHIEVEMENT MEANS

Nonparametric	H/W*	Degrees of Freedom	Significant values of H/W** .05 level	.01 level
Seventh Grade	3.5917	2	5.991	9.210
Eighth Grade	.2406	2	5.991	9.210

Parametric	F***	Degrees of Freedom Between	Within	Significant values of F**** .05 level	.01 level
Seventh Grade	1.62	2	133	3.07	4.78
Eighth Grade	1.21	2	160	3.06	4.75

*H results from the nonparametric analysis formula and is distributed as chi square. W is a correction factor for tied scores. Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences, (New York: McGraw-Hill Book Company, Inc., 1956), p. 188.

**Taken from Table E, Table of chi square, J. P. Guilford, Fundamental Statistics in Psychology and Education, (New York: McGraw-Hill Book Company, Inc., 1965), p. 582.

***F is the ratio of between-group variance with within-group variance.

****Taken from Table F, .05 and .01 points for the distribution of F, Ibid., pp. 583-586.

TABLE IV

RESULTS OF CHI SQUARE IN CONTINGENCY TABLES FOR DATA RELATING SCIENCE TO SIX SELECTED FACTORS

Comparison	Calculated X^2	Degrees of Freedom	Significance Level*
Science vs. Reading			
Seventh, '65-'66	68.27159	36	.00100
Seventh, '66-'67	86.28111	64	.03376
Seventh, '67-'68	122.73411	49	.00001
Eighth, '65-'66	104.61132	56	.00009
Eighth, '66-'67	61.34804	42	.02788
Eighth, '67-'68	107.54483	64	.00056
Science vs. Arithmetic Computation			
Seventh, '65-'66	47.83148	42	.24941
Seventh, '66-'67	92.70417	56	.00122
Seventh, '67-'68	127.07249	56	.00001
Eighth, '65-'66	53.43148	49	.31055
Eighth, '66-'67	66.76896	49	.04828
Eighth, '67-'68	132.25951	64	.00003
Science vs. Arithmetic Concepts			
Seventh, '65-'66	65.98778	42	.01081
Seventh, '66-'67	102.55426	64	.00163
Seventh, '67-'68	75.72048	49	.00895
Eighth, '65-'66	71.72953	49	.01960
Eighth, '66-'67	60.67295	42	.03188
Eighth, '67-'68	77.91010	56	.02824

*Taken from E.S. Pearson and H.O. Hartley, Biometrika Tables for Statisticians, Volume I (Cambridge: University Press, 1966), pp. 128-35.

TABLE IV (continued)

Comparison	Calculated X^2	Degrees of Freedom	Significance Level*
Science vs. Arithmetic Application			
Seventh, '65-'66	40.32479	36	.28803
Seventh, '66-'67	94.78889	56	.00097
Seventh, '67-'68	115.67186	49	.00001
Eighth, '65-'66	126.50546	56	.00001
Eighth, '66-'67	84.28450	49	.00120
Eighth, '67-'68	109.89380	64	.00033
Science vs. Sex			
Seventh, '65-'66	6.10951	6	.41218
Seventh, '66-'67	10.72444	8	.21969
Seventh, '67-'68	3.76814	7	.81351
Eighth, '65-'66	11.74898	7	.11118
Eighth, '66-'67	3.43979	7	.84148
Eighth, '67-'68	14.68074	8	.06754
Science vs. Mental Ability			
Seventh, '65-'66	83.28148	36	.00002
Seventh, '66-'67	90.55611	56	.00244
Seventh, '67-'68	107.30419	42	.00001
Eighth, '65-'66	88.21068	49	.00054
Eighth, '66-'67	77.22586	42	.00039
Eighth, '67-'68	102.26123	64	.00172

*Taken from E.S. Pearson and H.O. Hartley, Biometrika Tables for Statisticians, Volume I (Cambridge: University Press, 1966), pp. 128-35.

significant beyond the .001 level, thus showing a high correlation between science achievement and reading achievement. The importance of reading ability as a factor in science achievement was pointed out by Moore in a study where unit text materials for low-ability junior high school students were prepared and evaluated for effectiveness. The reading level was adapted to the abilities of the students. In comparison with students using other textbooks written for low-ability students, students using the prepared unit text materials scored significantly higher on a test which was also adapted to their reading ability. One of the characteristics of the unit text materials which received exceptionally high ratings by the teachers who used the units was the appropriateness of the reading level.[59]

For the three comparisons of science and arithmetic there were three cases which did not show significant relationships between science and arithmetic achievement. These cases, all during the 1965-66 school year, were the seventh and eighth grade in arithmetic computation and the seventh grade in arithmetic applications comparison. Further investigation would be necessary in order to try to explain these exceptions to the general significant relationship between science and arithmetic achievement.

As with Table II, the results shown in Table IV concerning science achievement and sex are contrary to what has been reported in other studies for this study showed no significant relationship between science achievement and sex. It may be that this sample was atypical in that

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[59]Arnold J. Moore, "The Preparation and Evaluation of Unit Text Materials in Science for Low-Ability Junior High School Students," Dissertation Abstracts, 22:1471, 1961.

respect, for in only one case, eighth '67-'68, .06754 level of significance, do we have a significance level close to the .05 level of significance. Hoedel stated that traditionally girls have been credited with high achievement in matters academic and cited a study by Ford which revealed a heavy preponderance of girls among over-achievers.[60] A further check on the range in Table II revealed that in only one case did the girls have the highest scores in science achievement. In the study reported by Wisenthal, the investigation was carried out among 1,164 boys and 1,085 girls in single-sex and mixed schools. Significant differences in favor of the girls were found in attainment, I. Q., and attitude toward school.[61] Tiegland and Winkler, reporting on a study made on fourth grade students, stated that it is possible to arrive at contradictory conclusions when using different criterion measures of ability and achievement.[62] It must be remembered, however, that the greatest variations between the sexes occur during adolescence.

The comparison between science achievement and mental ability yielded results as expected showing a significant relationship between the two. This is in agreement with the already well-established positive relationship between intelligence and school achievement.[63]

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[60]Hoedel, op. cit., p. 364.

[61]Wisenthal, op. cit., p. 79.

[62]John J. Tiegland and Ronald C. Winkler, "Is Underachievement Basically A Male Problem?" The Personnel and Guidance Journal, 44:431, December, 1965.

[63]Dewayne E. Keller and Vinton N. Rowley, "The Relations Among Anxiety, Intelligence, and Scholastic Achievement in Junior High School Children," Journal of Educational Research, 58:167-70, December, 1964.

Related Factors

Summarized in Table V, page 31, are descriptions of factors involved in the seventh-eighth grade science program at Halstead. The table includes information on the number of students enrolled in science, the teachers involved, the textbooks used, and the achievement test used. The enrollment ranged from 39 to 63 in the seventh grade and from 48 to 62 in the eighth grade. The teachers all had bachelor's degrees and at least one year previous teaching experience. Two of the three teachers each had 25 or more graduate hours. Information was not complete on the number of hours in science. Traditional-type textbooks were used in the first two years covered by the study and sequential-type texts were used the third year. The same achievement test was given all three years.

Not clearly evident on initial inspection of the table is a factor which could have had a bearing on the results of the study. This factor was that there was an increase of at least ten students in each grade in 1967-68 over what would have been expected from the previous year's enrollment. Comparing the seventh grade of 1966-67 with the eighth grade of 1967-68 there is an increase of 15 students. Having checked the sixth grade enrollment for 1966-67, there was an increase of 11 for the 1967-68 seventh grade. Further investigation revealed that most of the increase in both the seventh and the eighth grades was due to students being brought in to Halstead from outlying schools. Some factors related to this increase which could have affected achievement are teacher load, classroom conditions, type of school from which students came, and attitudes

TABLE V

DESCRIPTION OF THE MAIN FACTORS OF THE SEVENTH-EIGHTH GRADE SCIENCE PROGRAM IN THE HALSTEAD ELEMENTARY SCHOOL, 1965-1968

Factor	1965-66	1966-67	1967-68
No. of students enrolled in science	Seventh 48 Eighth 62	Seventh 39 Eighth 48	Seventh 63 Eighth 54
Teacher	I. Bachelor's degree 28 graduate hours 11 years previous experience, 4 of which at Halstead	II. Bachelor's degree 40 sem. hours in science (18 grad) 25 graduate hrs. 7 years previous experience	III. Bachelor's degree 33 sem. hrs. in biology 3 hrs. in phys. sc. one year previous experience
Textbook The same texts were used in 1966-67 as in 1965-66.	Seventh: <u>Adventures in Science</u> Unit titles: Our Solar System and the Universe, Our Soil, The Changing Weather, Using Electricity, Foods and Nutrition, Living Things Eighth: <u>Broadening Worlds of Science</u> Unit titles: The Earth and Its Resources, Water and Water Resources, Machines to Do work, The Human Body, Control of Disease, Transportation of People and Materials, Communication and Progress, Living Things and Their Environment		Seventh: <u>The World of Living Things</u> Eighth: <u>Investigating the Earth</u>
Achievement Test	The Stanford Achievement Test, Advanced Battery, was used all 3 years.		

of students and teachers.

Indicated in Table V is the fact that each year there was a different science teacher. This in itself would be an important factor affecting the results of the study. A fact not shown in the table is that teacher II was instrumental in the selection of the eighth-grade textbook for 1967-68 and teacher III was instrumental in the selection of the seventh-grade textbook for 1967-68. If teacher III did not regard the chosen text as highly as did teacher II, his attitude would influence his teaching methods. He would not be prone to be as enthusiastic about the text as he would be about one which he had selected himself.

The traditional-type textbooks which were used the first two years on which the study was based included a variety of topics with no unifying theme. There was also some overlapping from one year to the next. The sequential-type science program, with life science in the seventh and earth science in the eighth, was adopted in 1967 and textbooks were selected accordingly. It was strongly recommended when the earth science text was selected that the laboratory materials, especially designed for the laboratory investigations which receive strong emphasis in the course, also be purchased. This recommendation was not followed. Consequently, it is likely that students did not receive the full benefit of the course as it was originally designed.

A final factor listed in Table V is the test by which student achievement was measured. As noted, the same test was used all three years. At first thought, this may not seem to be a factor influencing the results of the study, but further investigation shows that it may have considerable significance. The Directions for Administering the test gives the following breakdown of science topics included in the science subtest and the approximate number of items per form of the test:[64]

Air and weather	6
Astronomy	3
Chemistry	5
Electricity and magnetism	4
Energy and machines	6
Light, sound	2
Earth science	5
Animals	5
Plants	5
Conservation	6
Body, health, food, safety, heredity	9
Science in industry and in everyday activities	2
Scientific method	2
	60

Taking the number of items listed for earth science, air and weather, astronomy, scientific method, and some chemistry and conservation, there would be approximately one-third of the items which would be covered in an earth science course. In life science the ratio would be about the same.

Considering the design of the test, in terms of student performance, it would seem that students in a traditional science program covering a range of topics would have the advantage over students in a sequential or specialized program covering one field of science in depth. Heath noted that when evaluating new curricula, the usual criterion test is designed to measure a type of achievement emphasized in only one of the curricula,

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[64]Kelley and others, Stanford Achievement Test, Directions for Administering, Advanced Battery (New York: Harcourt, Brace & World, Inc., 1964), p. 6.

and that curriculum is thereby at a great advantage in the analysis.[65] This would appear to be the case in this study for the test as designed would seem to favor the traditional curriculum.

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[65]Robert W. Heath, "Pitfalls in the Evaluation of New Curricula," Science Education, 46:216, April, 1962.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In 1967 the Halstead Elementary School adopted a sequential-type science program in the seventh and eighth grades to replace the traditional-type science program used previously. The purposes of this study were (1) to make a descriptive study of science achievement in the seventh and eighth grades for the past three years, 1965-68, and (2) to see what significance, if any, the results might have for further improvement of the science program in the Halstead schools.

Summary

All necessary data were obtained from the files and records in the offices of the Halstead Elementary School. Only those students for which there were complete sets of data on achievement and mental ability were included in the sample. Procedures used in analyzing the data included measures of central value and dispersion, analysis of variance, and chi squares in contingency tables. Correlations were not used because the sample groups did not fit the assumption of normal distribution.

The results are summarized as follows:

1. The total sample included 295 students which was 93.9 percent of the students enrolled in science during the three-year period. By grades there were 134 students in the seventh and 161 in the eighth.

2. The seventh grade sample was quite evenly divided according to sex with 68 boys and 66 girls. The eighth grade sample included 86 boys and 75 girls.

3. For the seventh grade, mean grade scores in science achievement were 9.93, 9.41, and 9.17. Eighth grade scores were 10.28, 10.29, and 9.73.

4. In each grade, all boys' mean scores were higher than the girls' mean scores.

5. In all classes but one the boys had the highest individual pupil score, and the widest range of scores occurred among the boys.

6. All means were lower than the respective medians, showing negative skewing.

7. Analysis of variance indicated no significant difference in the means among classes for each grade.

8. In the comparison of science achievement with reading achievement, all chi squares were significant beyond the .05 level with four being significant beyond the .001 level.

9. In the science vs. arithmetic computation comparison, two of the six chi squares were not significant, one was significant at the .05 level, and three were significant beyond the .001 level.

10. All chi squares were significant beyond the .05 level in the science vs. arithmetic concepts comparison.

11. One chi square was not significant at the .05 level in the science vs. arithmetic applications comparison; all others were significant beyond the .001 level.

12. There were no significant results in the comparison of science achievement vs. sex.

13. All the results in the science vs. mental ability comparison were significant beyond the .01 level, most being significant beyond the .001 level.

14. Factors identified which may have influenced the results of the study were increased enrollment, different teachers each year, and

achievement test which appears to favor traditional science.

Conclusions

The following conclusions resulted from the study:

1. None of the classes were normally distributed, each exhibiting some negative skewing, which might be due to underachievement on the part of higher-ability students.

2. All the seventh and eighth grade sample classes have been achieving well above the population norms for their respective grades.

3. Contrary to the findings of other studies, the boys achieved higher than the girls, but no significant relationship was found to exist between science achievement and sex.

4. There was no significant change in science achievement within each grade over the three-year period.

5. Significant relationships were found to exist between science achievement and each of the following: reading achievement, arithmetic achievement, and mental ability.

6. Further study involving other factors needs to be made before any major conclusions are drawn concerning the effectiveness of the new sequential science program.

Recommendations

The following recommendations are based on the review of the literature and the results and conclusions of the study:

1. As much as possible, adaptations should be made for reading ability to allow students with low ability to benefit more fully from the program.

2. Laboratory materials which are lacking should be provided in order that students may carry through the investigations which are an integral part of the course.

3. Further study needs to be made concerning the appropriateness of tests used in measuring achievement in science when new sequential curricula are used.

4. In light of the negative skewing exhibited by each class, consideration might be given to providing further enrichment activities for the higher-ability students.

5. Continual evaluation should be done. In conjunction with the high school science faculty a study might be done assessing the effect of the new seventh-eighth grade science program on the enrollment in high school science courses.

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A STUDY OF SCIENCE ACHIEVEMENT IN THE SEVENTH AND EIGHTH GRADES OF THE HALSTEAD ELEMENTARY SCHOOL, HALSTEAD, KANSAS 1965-1968

by

WILLARD GEORGE EBERSOLE

B. A., Goshen College, 1954

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Physical Science Teaching

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

In 1967 the Halstead Elementary School adopted a sequential-type science program in the seventh and eighth grades to replace the traditional-type science program used previously. The purposes of this study were (1) to make a study of the science achievement in the seventh and eighth grades of the Halstead Elementary School for the scholastic years 1965-66 through 1967-68; and (2) to determine what significance, if any, the results might have for the improvement of the science program in the Halstead Elementary School.

Specific factors considered in the study were the mean achievement in science for each grade from year to year and science achievement in relation to each of the following: reading achievement, arithmetic achievement (computation, concepts, and applications), sex, and mental ability. Data were compiled from the files and records in the offices of the Halstead Elementary School. Only those students for which there were complete sets of records on achievement and mental ability were included in the study. Statistical procedures used in analyzing the data included frequency distributions, measures of central value and dispersion, analysis of variance, and chi square in contingency tables.

The results are summarized as follows:

1. The total sample included 295 students or 93.9 percent of the students enrolled in science during the three-year period. In the seventh grade sample there were 134 students; the eighth had 161 students.

2. According to sex, the seventh grade had 68 boys and 66 girls, and the eighth grade had 86 boys and 75 girls.

3. For the seventh grade, mean grade scores in science achievement were 9.93, 9.41, and 9.17. Eighth grade scores were 10.28, 10.29, and 9.73.

4. In each grade, all boys' mean scores were higher than the girls' mean scores.

5. In all classes but one the boys had the highest individual pupil score, and the widest range of scores occurred among the boys.

6. All means were lower than the respective medians.

7. Analysis of variance indicated no significant difference in the means among classes for each grade.

8. In all comparisons except science achievement vs. sex, chi square results indicated significant relationships. Two classes in the arithmetic computation comparison and one class in the arithmetic applications comparison did not have significant values. All other values were significant beyond the .05 level with over half being significant beyond the .001 level.

9. Related factors identified which may have influenced the results of the study were increased enrollment, different teachers each year, and an achievement test which appears to favor traditional science.

It was concluded from this study that:

1. The sample classes exhibited negative skewing which might be due to underachievement on the part of higher-ability students.

2. All the seventh and eighth grade sample classes have been achieving well above the population norms for their respective grades.

3. Contrary to other findings, the boys achieved higher than the girls, but no significant relationship was found to exist between science achievement and sex.

4. There was no significant change in science achievement within each grade over the three-year period.

5. Significant relationships were found to exist between science achievement and each of the following: reading achievement, arithmetic achievement, and mental ability.

6. Further study involving other factors needs to be made before any major conclusions are drawn concerning the effectiveness of the new sequential science program.

Based on the review of the literature and the results and conclusions of the study, the following recommendations were made:

1. As much as possible, adaptations should be made for reading ability to allow students with low ability to benefit more fully from the program.

2. Laboratory materials which are lacking should be provided in order that students may carry through the investigations which are an integral part of the course.

3. Further study needs to be made concerning the appropriateness of tests used in measuring achievement in science when new sequential curricula are used.

4. In light of the negative skewing exhibited by each class, consideration might be given to providing further enrichment activities for the higher-ability students.

5. Continual evaluation should be done. In conjunction with the high school science faculty a study might be done assessing the effect of the new seventh-eighth grade science program on the enrollment in high school science courses.