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The situation test as a method of problem solving in science teaching on the sixth grade level

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THE SITUATION TEST
AS A METHOD OF PROBLEM SOLVING IN SCIENCE TEACHING
ON THE SIXTH GRADE LEVEL

A Thesis

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Master of Science in Education

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by

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APPROVAL SHEET

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PREFACE

This study was conducted under the direction of Dr. E. F. Overton, chairman of the Department of Education, University of Richmond.

This thesis is the result of a desire to choose a subject that would not only teach the author how to prepare a thesis, but that might also help other elementary school teachers to use science in a more effective way in the classroom.

Acknowledgement is made to the many authors whose names appear in the bibliographic and footnote material, as well as to the following personnel of the Richmond Public Schools: Dr. Jack Boger, co-ordinator of elementary education, who has been untiring in his efforts to make available to me the resources of his department, and his invaluable guidance; Dr. Charles Turner, assistant director of research; Miss Helen C. Phillips, principal of J. E. B. Stuart Elementary School; Miss Harriett Snow, former science teacher at Thomas Jefferson High School; and Mrs. Elizabeth Collier, sixth grade teacher at William Fox Elementary School.

Without the cooperation and assistance from the groups of people listed above, it would have been impossible to complete this study. It is believed by the author that this study may be used to encourage the development of science and testing in the field of education.

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CHAPTER I

THE ROLE OF ELEMENTARY SCIENCE

Recent Emphasis Upon Science

In an article, "Today's Elementary School," its author sums up present science teaching: "Science, which originally made its way into elementary school as nature study, appears to be attaining a broader and more important status. The teaching of science at the elementary level is still in its formative stage. To my observation, the content is largely dominated by the text with very little experimentation and practical work."[1]

Research states that elementary science is about twenty-five years old—a recent addition to the curriculum. Changes in a new area in elementary teaching usually come slowly. The rapid development of the science program has resulted from the tremendous pressure of various groups to gain child attention. The weight of national and international events have forced public opinion to consider science teaching in the elementary school as a necessity.[2]

The American elementary school is a unique institution. It is the foundation for the education of the citizens in a democracy. This assigns to the elementary school teacher many professional tasks. She becomes a specialist in the education of children. Teaching science is only one of her functions.[3]

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[1]Henry Harap, "Today's Elementary School," NEA Journal, Vol. 46, No. 2, (February, 1957), pp. 78-80.

[2]Gerald S. Craig, Science in the Elementary Schools, National Education Association, First Edition, April, 1957, p. 1.

[3]Herman Schneider and Nina Schneider, Teacher's Guide for Today and Tomorrow, (Boston: D. C. Heath and Company, 1956), pp. 10-12.

To meet such pressing need many elementary teachers have reached beyond the textbook of science and experimented with new activities, new content, and new methods. It would seem that one lives best who knows the "secrets" of the environment. Learning such secrets needs interpretation. This term implies more than either explanation or understanding. Interpretation means solving an environmental problem by: thinking, planning, using hands and materials, persisting until a solution is found.[4]

How soon should science instruction begin in elementary school? It is held by one writer that children question natural phenomena at an early age.[5] Schneider advances the idea that if one thinks of science as a tool subject, like arithmetic or reading, all elementary school boys and girls can learn science.[6] The skilled, creative scientist can develop from the group and can go to specialized schooling at the proper time. If children are to be "science-minded," it appearsthat growth in that direction should begin at an early age.

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[4]Craig, op. cit., p. 3.

[5]Mervin E. Oakes, Children's Explanations of Natural Phenomena, Bureau of Publications, Teacher's College, Columbia University, (New York: 1947), p. 151.

[6]Herman Schneider and Nina Schneider, Teacher's Edition, Science in Our World, (Boston: D. C. Heath and Company, 1956), p. 11.

The Nature of Science-Mindedness

What the individual derives from study is limited by (1) the information gotten from the study; (2) understanding of basic principles; and (3) changed behavior that becomes a part of the individual. This leads one to ask, "What does science do to or for children?"[7]

Through science man endeavors to find a better understanding of the world. Reliable sources are necessary, not gossip, rumor, prejudice, or the like. Science is an active field, constantly demanding new observations and a challenge to an earlier conclusion. It is a growing subject, probably only beginning. There is much that scientists have not explained satisfactorily. This means that a fact cannot be taught as though it were true forever. So one determines what is the most reliable information at a given time. It would appear that learning takes place through continuous growth and development of large concepts. This idea is consistent with the nature of modern science.

The products of science are an important part in life: solving problems of health, recreation, social life, shelter, communication,

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[7]Division of Instruction, Richmond Public Schools, "Elementary Teachers' Science Bulletin," (Richmond: Richmond City Schools, November, 1956), p. 1. (Mimeographed.)

production of goods, transportation, and conservation of natural resources. This being true, the elementary school must offer children the opportunity to learn specific knowledge and understandings, an appreciation of the scientific method, and the use of this method in solving human problems.[8]

Such elementary school science writers as Will R. Burnett[9] and Nina and Herman Schneider[10] contend that science is a two-edged sword and that teachers must base their teaching on the philosophy that science is a human project with a social responsibility. Whatever adds to the importance and dignity of human beings is good; whatever subtracts is evil.

The most important aspect of what science does for children is changes in behavior because "(1) changes in behavior are the crucial fruits of learning and (2) changes in behavior that are in the proper direction lead the individual to acquire information and understandings that are related to real needs and real goals."[11]

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[8]Division of Instruction, A Tentative Guide for Science, Grades 1-12, Part I, General Science in Grades 1-9, State Board of Education, (Richmond: January, 1956) p. 1.

[9]R. Will Burnett, Teaching Science in the Elementary School, (New York: Rinehart and Company, Inc., 1955), p. 159.

[10]Schneider, op. cit., p. 12.

[11]Tests and Measurement, edited by Dr. Jack Boger, Department of Instruction, Research Division, Richmond Public Schools, (1951).

It would seem that creating science-mindedness would mean the development of the following traits or aptitudes: "reasoning power, accuracy, intellectual honesty, open-mindedness, objectivity, originality, discernment, good memory, independence, persistence, purposefulness, alertness, application, executive ability, humility, impartiality, native intelligence, self-confidence, cooperation, consistency, constructivity, courage, drive, efficiency, faith, keenness of observation, curiosity, creativeness, poise, and self-control."[12]

Which are the essential traits? According to Paul F. Brandwein[13] such characteristics as questing, persistence, and manual dexterity are necessary to science-mindedness.

Questing means a dissatisfaction with things as they are. It results in curiosity which asks, "Why?" and "How?"

Persistence means a willingness to give extra time beyond the regular schedule to solving a problem. It means work at home through choice and not assignment. It means a willingness to face failure and yet desire to keep on.

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[12]Frederick L. Whitney, The Elements of Research, (New York: Prentice-Hall, Inc., 1950), p. 44.

[13]Paul F. Brandwein, The Gifted Student as Future Scientist, (New York: Harcourt Brace and Company, 1955), pp. 9-11.

Manual dexterity means an adequate neuromuscular control (Particularly of the hands). Science is neither learned nor its principles discovered by reading about science. Manipulation helps in discovering its principles. This genetic factor becomes increasingly important if the student desires to become a future scientist. "The more a muscle works, the more it develops," said Dr. Alexis Carrel. "Activity strengthens it instead of wearing it out."[14]

Creative imagination and problem solving ability are essential to science-mindedness. These traits combine effort with imagination. Creative power can be stimulated into growth. The best of all creative exercises is problem solving.[15]

Science is learned and its principles applied through observation, manipulation, experimentation, verification and adoption. The ability to spot a problem or detect inconsistencies is a trait that combines this philosophy of science and makes it necessary to a creation of science-mindedness.[16]

A list of science traits which science teachers might agree upon as essential would include: (1) curiosity, (2) creative imagination, (3) persistence, (4) manual dexterity, (5) planning-proving ability, (6) ability to spot a problem or detect inconsistencies.

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[14]Alex F. Osborn, Applied Imagination, (New York: Charles SScribner's Sons, 1953), p. 94.

[15]Ibid., Preface vii.

[16]Division of Instruction, Louisville Public Schools, "A Source Book of Science Experiences for Elementary School Children," (Louisville: Louisville Public Schools, September, 1954), Vol. 2, Part I, p.4. (Mimeographed.)

In a science workshop held in the summer of 1956 at Binford Junior High School, Richmond, Virginia, a group of supervisors and science teachers approved this list of traits as essential to science-mindedness.

Statement of the Problem

Problem solving and how we learn was the theme of the Fourth National Convention of Science Teachers Association, for 1956. This selection of theme was made because of an established observation that problem solving is characteristic of all human life. Man is outstanding among other forms of life because of his ability to cultivate his problem solving activities.

A new dimension, the scientific approach to problem solving, is the nature of this investigation. In solving problems we learn many skills, facts, principles; develop insight, enhance intelligence.[17]

This study is concerned with the teaching of elementary school science in a partially structured curriculum with a few basic topics or problems, allowing the teacher opportunity to use current interests of children in building the bulk of the program. The hypothesis of this study is: A problem solving situation test introduced to a special team of five students to interact with the remainder of the class and produce significant learning.

There are two major questions with which this study is concerned: (1) Do these children acquire more science information than a control group using the completely incidental approach to science? (2) Do these children show growth in behavior traits to a greater degree than the control group?

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[17]Herman Schneider, "What Can Elementary Science Do?" Science Curriculum Service, Science Notes, Vol. 13, No. 1, (New York: Scott, Foresman and Company, Winter, 1954), p. 1

CHAPTER II

THE NATURE OF THE PROBLEM SOLVING SITUATION TEST

Setting the Stage

The measurement of the behavior traits of five pupils working to solve a science problem can be difficult. At the beginning of the study of the problem, an unhurried introductory session with the class can allow the children to express themselves. An atmosphere of informality provides for children to react to learning in a favorable session because the children feel at ease and free from a testing situation.

Besides the project of the group of five, the class can pick its own team to solve a problem similar in nature to that of the experimental team. Such measures do lead to favorable learning situations as well as the opportunity to attempt to evaluate the presence of and growth in behavior traits. However, it is hazardous to predict how children will react to a situation.

What kinds of situations are valuable as situational tests? A promising lead is the stimulus type situation concrete and uniform enough for comparisons. It is structured and controlled enough to allow pupils to be tested in the type of behavior imposed by test. A promising approach is to place before an experimental team of five children a problem and materials needed to solve it. Opportunity for the ideas to be tossed about in the thinking of the group and to be tested by experimentation are given. The team demonstrates the use of the materials made available, and keeps a record of its procedure to share with others. Such an approach presents opportunities for learning and testing. Under such conditions, observers can rate specific traits. This is a dynamic and positive approach to locating children in their learning and it is one that corresponds to how children grow and learn.[18]

The situational test is difficult to design, but it does offer promise for the assessment of typical behavior traits. The test maker begins with a list of traits he wishes to test for, defines those traits as completely as possible, then devises problem situations which demand exercise of these traits in their solution.

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[18]Bernice Baxter, Gertrude Lewis, and Gertrude Cross, The Role of Elementary Education, (New York: D. C. Heath and Company, 1955), Part II, pp. 36-45.

Judging Behavior Traits

There are degrees in behavior traits, and there are opportunities at all levels to improve these traits. Behavior traits of beginning school children are not as refined as the behavior traits of a college senior. Yet, because the thinking of young children often displays elements of criticalness, these elements may be improved and refined under teacher guidance.[19]

There is difficulty in measuring the degree of curiosity, creative imagination, persistence, etc., that a child possesses. In a group situation which of two, or for that matter, five, children have the most of each element? Has persistency in a child improved from September to May? "The only way to be even moderately certain that the behavior is typical is to study the subject on many occasions of the type about which we wish to generalize."[20]

An observer may record certain specific items to which his attention is directed. Standardization of observation is greatly increased if every observer notes a limited number of specific countable behaviors. Objectivity of observations is obtained by defining carefully what is to be noted and providing a check list schedule, or recording form for uniform data.[21]

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[19] Gerald S. Craig, Science in the Elementary Schools, Department of Classroom Teachers, American Education Research Association of NEA, (April, 1957), p. 24.

[20] Lee J. Cronbach, Essentials of Psychological Testing, (New York: Harper Bros., 1949) p. 387.

[21] Ibid., p. 392.

An anecdotal record offers further scoring possibilities. It escapes the bleakness and narrowness of quantitative methods, and it offers a more lifelike representation of the subject. The observer can rate any type of behavior that has a significant aspect. Such a record accumulated over a period of time offers a richer picture of behavior than any other equally simple technique.

The observer must report incidents worth reporting, and he must be objective. Characteristic incidents should be recorded. Incidents that are striking exceptions to normal behavior are important. The reporter selects what he feels is relevant.[22]

A recording on tape of the situation test offers further possibilities of evaluation.

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[22]*Ibid.*, p. 395.

CHAPTER III

THE CHILDREN INVOLVED

The Experimental Class

The experimental class used a partially structured curriculum (a few basic topics) which afforded opportunity for the teacher to use the current interests of children. This method permitted a variety of procedures and a chance to bring new children into positions of leadership. The children participated in the development of the planning by the use of experiences, experiments, discussion, reading to secure their learning, and the situation problem solving test.

The materials used were simple. Most of it came from the community. A hot plate, dishes, jars, Reynolds wrap, sand, straw, humus, soil, bottles, candles, drinking straws, magnets, dry cell batteries, and insulated wire are examples of the kinds of materials that were used.

The selection of the five students to be used in the controlled situational test deserved much consideration. These students should learn for themselves, stimulate interaction with others, and serve the observers in their rating of essential science characteristics.

"Urgent, and of the first order of priority, is our need to look to one of our critical national resources--youngsters of high level ability in science.

"Successful work with students of high level ability on the school level does not usually go on unless successful work with the average student and the so-called slow learner goes on as well."[23]

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[23]Brandwein, *op. cit.*, Preview and Summary, p. 14.

Using this authority as a basis for choice, The National Achievement Tests-Elementary Science Tests, (For Grades 4-6 Inclusive), was given to the experimental class.[24] A high science score and a middle science score was used to select two of the five children in the experimental group. This test served a dual purpose: the choice of two members on the experimental team, and as a valid test of science information as validity is ordinarily conceived.[25]

Table I indicates the two members selected as participants on the experimental team, and the results of science knowledge of the class as shown by this test. The class was tested in: Part I, "Practical Applications," Part II, "Cause and Effect Relationship," Part III, "Miscellaneous Facts," Part IV, "Simple Identification," and Part V, "Evaluation." The total score indicates how many points out of a possible 125 points each pupil received.

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[24]Lester D. Crow, Ph.D., and W. L. Shuman, National Achievement Tests, Elementary Science Test, Form A, (New York: Acorn Publishing Company, 1948).

[25]Oscar K. Buros, Mental Measurement Yearbook, (Connecticut: Brounsworth and Company, 1941), Vol. II, pp. 1029-31.

TABLE I

RESULTS FOR ELEMENTARY SCIENCE TEST, FORM A,
FOR EXPERIMENTAL CLASS, GIVEN IN SEPTEMBER, 1956
GRADE 6 LOW, DATE TESTED 9-26-56

Pupil's Name		Parts					Score
		I	II	III	IV	V	
1.	Fromm	22	23	25	25	15	110
2.	Haynes*	23	19	23	24	16	105
3.	Prout	20	20	22	24	19	105
4.	Hill	21	20	24	22	15	102
5.	Hagen	21	20	23	25	11	100
6.	Lucy	20	21	23	21	12	97
7.	Taylor	22	18	23	20	14	97
8.	Martin	21	18	21	22	14	96
9.	Alexander	22	14	19	23	16	94
10.	South	20	18	18	24	14	94
11.	Murphy	18	17	19	22	17	93
12.	Hamilton	18	21	17	22	15	93
13.	Merriman	16	15	25	23	14	93
14.	Booth	16	15	22	24	15	92
15.	Clyborne	16	17	24	20	14	91
16.	Gentry	19	19	21	20	12	91
17.	Dean	19	14	22	21	13	89
18.	Terrell*	21	14	20	17	14	86
19.	Metzger	21	15	18	17	14	85
20.	Schaaf	16	18	22	15	13	84
21.	Moore	16	14	21	21	12	84
22.	Boothe	17	17	22	16	11	83
23.	Bengel	13	15	18	22	15	83
24.	Thompson	12	16	22	24	1	75
25.	Dowmer	18	16	21	8	11	74
26.	Gordon	16	10	16	18	12	72
27.	Jones	12	17	17	13	12	71
28.	Barrons	14	13	13	17	14	71
29.	Kerr	13	9	15	20	13	70
30.	Dixon	10	14	21	24	1	70
31.	Morgan	15	17	20	16	0	68
32.	Williams	20	19	19	8	0	66
33.	Linkous	10	18	14	10	13	65
34.	Wade	9	8	10	4	1	32

*Member of Experimental Team

Dr. Brandwein, in his book The Gifted Student as Future Scientist, tells of his work since 1951, in which he tries to answer the question whether there were characteristics peculiar to students with science ability. Slowly he accumulated evidence to which other observers agreed. This evidence was that a Genetic Factor, based on heredity (general intelligence, numerical ability, and verbal ability), was necessary.[26]

The California Test of Mental Maturity was used as a basis for selecting a child high in mental ability.[27] The type of mental ability chosen was composed of verbal and numerical ability. A child who scored the average in these abilities was also selected.

Table II indicates the choice of two members of the experimental team. It also shows the Total I. Q., Language I. Q., and Non-Language I. Q. of the class. The class median in each of these is indicated.

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[26] Brandwein, *op. cit.*, p. 9.

[27] Ernest W. Tiegs and Willis W. Clark, *California Test of Mental Maturity*, Form AA, (California: California Test Bureau, 1951).

TABLE II

RESULTS FOR CALIFORNIA TEST OF MENTAL MATURITY GIVEN TO EXPERIMENTAL CLASS—GRADE 6 LOW, DATE TESTED 9-19-56

PUPIL'S NAME	TOTAL I.Q.	LANGUAGE I.Q.	NON-LANGUAGE I.Q.
1. Fromm	136	134	151
2. Taylor	138	113	110
3. Haynes	135	149	106
4. Hagen*	131	128	130
5. Martin	128	119	122
6. Thompson	125	125	128
7. Bengel	129	117	137
8. Hill	129	133	120
9. Murphy	128	130	124
10. Booth	115	122	115
11. Downer	116	112	127
12. Merriman	118	120	120
13. Hamilton	122	122	122
14. Clyborne	118	116	124
15. Gentry	105	106	101
16. Moore	114	104	127
17. Kerr*	108	118	113
18. Schaaf	112	122	118
19. Dixon	113	109	125
20. Williams	110	106	122
21. Terrell	102	91	111
22. Doan	104	108	97
23. South	105	111	93
24. Metzger	96	92	102
25. Prout	103	102	96
26. Lucy	103	118	79
27. Morgan	99	90	113
28. Barrons	98	92	106
29. Gordon	94	95	93
30. Jones	83	90	73
31. Linkous	83	79	106
32. Wade	91	96	88

*Chosen to serve on Special Science Team

I.Q.:	70 to 74	75 to 79	80 to 84	85 to 89	90 to 94	95 to 99	100 to 104	105 to 109	110 to 114	115 to 119	120 to 124	125 to 129	130 to 139	140+
Total			2		2	3	4	3	5	3	1	5	4	
Language		1			5	2	2	4	3	5	5	1	3	1
Non-Lang.	1	2			2	2	2	3	4	4	8	3	2	1

	Median	Number
Total	112	32
Language	114	32
Non-Language	114	32

Lane and Beauchamp in their book Human Relations in Teaching help teachers to understand what it means to be human and effectively analyze the premise that all human behavior is social in origin and purpose. Here the authors maintain that teaching is the art of arranging conditions to challenge responses that aid in the development of rich, warm, sensitive human beings.[28]

Northway utilized sociograms in determining the children who are not liked or wanted by other children.[29] The fifth member of the group was the most popular person in the group. The class did the picking through the use of a sociometric test. This type of test indicates the degrees to which individuals are accepted in a group. The children were asked to write down in rank order of preference the names of three members of the class they would most enjoy playing with at recess, working with on a science problem, and inviting to their homes if they were to have a party. It was found that some children were popular and some few children were "isolates." Tables III and IV indicate the results of the sociometric test for the experimental class.

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[28]Howard A. Lane and Mary Beauchamp, Human Relations in Teaching, (New York: Prentice-Hall, Inc., 1955), Section I, pp. 15-17.

[29]Mary L. Northway, A Primer of Sociometry, (Canada: University of Toronto Press, 1952) p. 3.

TABLE III

TABULATION OF VOTES ON SOCIOMETRIC TEST GIVEN TO EXPERIMENTAL CLASS (BOYS)

	Alexander	Bengel	Downer	Fromm	Gentry	Hagen	Jones	Lucy	Martin	Morgan	Prout	Rice	South	Taylor	Terrell	Williams	Totals on each criterion	Combined	Girls voting for Boys	Grand Total
	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	18	18		
Haynes											010						010	1		
Thompson					011												011	2		
Hill		001										011					012	3		
Williams	100											100					200	2		
Terrell		100												001		010	111	3		
Taylor																	000	0		
South	010						011			100							121	4		
Rice																	000	0		
Prout				101					100						100		301	4		
Morgan						010			001		100		100				211	4	2	6
Martin				010		101										100	211	4		
Lucy	001									001			011				013	4		
Jones																	000	0	1	1
Hagen									010								010	1		
Gentry			111				100							100	001		312	6	2	8
Fromm														010			010	1		
Downer		010			100			111								001	222	6		
Bengel											001				010		011	2		
Alexander										010							010	1		

TABLE IV

TABULATION OF VOTES ON SOCIOMETRIC TEST GIVEN TO EXPERIMENTAL CLASS (GIRLS)

	Barrons	Booth	Boothe	Clyborne	Dean	Dixon	Gordon	Hamilton	Haynes	Hill	Kerr	Linkous	Merriman	Metzger	Moore	Murphy	Schaaf	Thompson	Wade	Gentry	Morgan	Jones	
Barrons					111																		3
Booth									010				001				100						3
Boothe				010					001					100									3
Clyborne													100	010							001		3
Dean													001			100				010			3
Dixon							100						011										3
Gordon						110								001									3
Hamilton									010							001	100						3
Haynes			001	010									100										3
Hill													111										3
Kerr										100							001				010		3
Linkous			110																			001	3
Merriman										101								010					3
Metzger											Absent												-
Moore											Absent												-
Murphy										010								100	001				3
Schaaf					100				001			010											3
Thompson													010	100						001			3
Wade				001					010							100							3
Totals on each Criterion	000	000	111	021	211	110	100	000	032	211	000	010	334	211	000	201	201	110	001	011	011	001	51
Combined	0	0	3	3	4	2	1	0	5	4	0	1	10*	4	0	3	3	2	1	2	2	1	51
Boys voting for girls									1	3								2					
GrandTotal									6	7								4					

* The most popular child in the Experimental Class is Freida Merriman.

The class was so motivated by the work of the experimental team that group work, committee work, pupil-teaching planning, and individual planning resulted. The entire class was drawn into the science program. As a result of this, a situation developed in which teaching became an arrangement of conditions that challenged responses leading toward a development of resourceful and creative human beings.

The Control Class

The control class was chosen because its background and mental ability was similar to that of the experimental class. The largest area of difference in the two groups was in the methods used in teaching science. Science was taught from the textbook or in a completely incidental way with set up objectives, but the teacher determined how and what to do on the basis of the interest of the children.

Table V shows results of the California Test of Mental Maturity given to the control class. The choice of two members of the control team is indicated. The individual I. Q. is noted, and the class median is indicated.

TABLE V

RESULTS FOR CALIFORNIA TEST OF MENTAL MATURITY GIVEN TO CONTROL CLASS--GRADE 6 LOW, DATE TESTED 9-25-56

PUPIL'S NAME	TOTAL I.Q.	LANGUAGE I.Q.	NON-LANGUAGE I.Q.
1. Buford*	127	126	121
2. Failing	122	128	108
3. Hanson	122	138	111
4. Ritchie	125	120	132
5. Spurr	125	125	129
6. Hicks	120	117	129
7. Gunn	117	118	116
8. Garza	116	116	116
9. Williams	118	118	120
10. Roberts	118	120	112
11. Harvey	121	124	115
12. Cleaton	111	109	117
13. Breedon	115	115	112
14. Crawley	117	120	105
15. Shepherd	114	114	110
16. Berkeley	111	106	121
17. Bareford*	105	103	105
18. Craven	103	103	102
19. Tuck	93	95	89
20. Robertson	93	92	93
21. Carroll	86	86	86
22. Duff, O.	81	72	94
23. Pollard	96	96	102
24. Atkins	93	88	103
25. Shinault	96	91	104
26. Heaton	90	96	84
27. Newsome	92	85	105
28. Mofford	82	85	75
29. Landrum	84	96	70
30. Lindsey	68	64	76
31. Duff, D.	75	82	67
32. Nunnally	62	59	64

*Member of Control Team

I.Q.:	55 to 64	65 to 69	70 to 74	75 to 79	80 to 84	85 to 89	90 to 94	95 to 99	100 to 104	105 to 109	110 to 114	115 to 119	120 to 124	125 to 129	130 to 139
Total		2		1	2	2	5	2	1	1	3	6	4	3	
Language	2		1		1	4	2	4	2	2	1	5	4	3	1
Non-Lang.	1	1	1	2	1	2	2	[illegible]	4	4	4	4	3	2	1

	Median	Number
Total	110	32
Language	105	32
Non-Language	107	32

The Elementary Science Test, Form A, was given to measure the science knowledge of the control class in September of 1956. It was used also to select two members of the control science team. Table VI indicates these results.

TABLE VI

RESULTS FOR ELEMENTARY SCIENCE TEST, FORM A, FOR CONTROL CLASS, GIVEN IN SEPTEMBER, 1956 GRADE 6 LOW, DATE TESTED 9-25-56

Pupil's Name	Parts I	II	III	IV	V	Score
1. Buford	23	20	25	24	17	109
2. Gunn	21	20	24	24	14	103
3. Hanson*	18	18	24	25	16	101
4. Failing	20	18	23	23	15	99
5. Cleaton	23	20	22	20	13	98
6. Shepherd	18	19	21	22	16	96
7. Hicks	17	18	20	24	15	94
8. Berkeley	19	17	22	20	14	92
9. Heaton	16	17	23	22	14	92
10. Crawley	15	15	22	21	15	88
11. Ritchie	20	17	19	23	9	88
12. Williams	16	17	21	20	14	88
13. Spurr	19	23	12	20	14	88
14. Harvey	22	15	19	17	14	87
15. Mefford	21	16	17	22	11	87
16. Shinault	14	16	20	21	15	86
17. Garza*	15	17	23	17	13	85
18. Roberts	12	18	19	19	13	81
19. Breeden	15	15	20	18	13	81
20. Landrum	12	15	20	18	12	77
21. Newsome	16	12	18	21	9	76
22. Tuck	15	14	13	15	16	73
23. Bareford	9	15	16	21	11	72
24. Atkins	16	11	14	18	12	71
25. Craven	14	15	13	13	12	67
26. Robertson	11	14	15	14	11	65
27. Duff, O.	11	15	11	16	12	65
28. Carroll	10	12	11	11	14	58
29. Lindsey	12	14	4	13	11	54
30. Pollard	12	10	7	11	13	53
31. Nunnally	11	12	11	9	5	48
32. Duff, D.	8	7	6	5	12	38

*Member of Control Team

A sociometric test was given to the control class, and the most popular student in the estimation of the class was selected. This student was the fifth member of the control team. Tables VII and VIII indicate this choice.

TABLE VII

TABULATION OF VOTES ON SOCIOMETRIC TEST GIVEN TO CONTROL CLASS (BOYS)

	Berkley	Buford	Duff, O.	Garza	Gunn	Harvey	Hicks	Hefford	Nunnally	Pollard	Shinault	Totals on each Criterion	Combined	Girls voting for Boys	Grand Total
	3	3	3	3	3	3	3	3	3	3	3	33	33		
Shinault		001					010					011	2		
Pollard	011			010	111	010						142	7		
Nunnally												000	0		
Hefford						101						101	2		
Hicks								010				010	1		
Harvey								101				101	2		
Gunn												000	0		
Garza	100	010	111				101			111	111	544	13		
Duff, O.												000	0	4	4
Buford												000	0		
Berkley		100		101					111			312	6		

TABLE VIII

TABULATION OF VOTES ON SOCIOMETRIC TEST GIVEN TO CONTROL CLASS (GIRLS)

	Atkins	Bareford	Breeden	Carroll	Cleaton	Crawley	Duff, D.	Failing	Hanson	Heaton	Landrum	Craven	Newsome	Ritchie	Roberts	Robertson	Shepherd	Spurr	Tuck	Williams	Duff, O.	Lindsey	
Atkins			010		001						100												3
Bareford						011					100												3
Breeden											111												3
Carroll														010							101		3
Cleaton			101			010																	3
Crawley														001						110			3
Duff, D.						100								001								010	3
Failing						011														100			3
Hanson								111															3
Heaton							101	010															3
Landrum				111																			3
Lindsey											010					001				100			3
Craven		100	010						001														3
Newsome						111																	3
Ritchie						101														010			3
Roberts											110							001					3
Robertson						111																	3
Shepherd									111														3
Spurr															111								3
Tuck						010															101		3
Williams						111																	3
Total each Criterion	000	100	121	111	001	576	101	121	112	000	431	000	000	012	111	001	000	001	000	320	202	010	63
Combined	0	1	4	3	1	18*	2	4	4	0	8	0	0	3	3	1	0	1	0	5	4	1	63

* The most popular child in the Control Class is Carolyn Crawley

A team of five children from the control class was chosen as a control team, but no effort was made to teach them except within the large group. The control team was selected by the use of the same tests as those given the experimental team. These five children were chosen as a basis of comparison with the experimental team, not because they would have a specific function in the control class.

CHAPTER IV

THE TESTS INVOLVED

The Problems Used, The Children's Reaction, and Observer Rating

The experimental team of five children was faced with a problem and the materials needed to solve it. They observed carefully. They worked cooperatively to exchange experiences so that all could benefit from the observations and experiences of each member of the group.

The children observed, searched, and thought through their observations. A cause and effect relationship was noted often. Such thinking led to the making of hypotheses. They checked the accuracy of their reasoning by observation and experimentation. This allowed the observations and experiments to speak for themselves. Conclusions were formed on the basis of reasoning and on evidence from observing experiments.

The use of these factors is the root of the scientific method.[30]

An anecdotal record was made of each problem solving situation test. An attempt was made to record on tape the voices of the experimental team in each situation.

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[30] R. Will Burnett, Teaching Science in the Elementary School, (New York: Rinehart and Company, Inc., 1953), p. 155.

Observers attempted to use time sampling in a set of scheduled observations planned in advance. Cronbach says that this is a way of obtaining data which permits precise comparisons of different individuals. This method offers a cumulative picture that is more typical than an equal amount of evidence obtained in a few larger observations. Objectivity of observation was obtained by providing a check list for recording uniform data.[31]

The traits noted were: curiosity, persistency, creative imagination, manual dexterity, planning-proving ability, and the ability to spot a problem and detect inconsistencies.

The pages which follow give the situation problem solving tests, the children's reactions to them, a sampling of observer opinion, and the results of observer rating in traits.

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[31] Leo J. Cronbach, Essentials of Psychological Testing, (New York: Harper Brothers, 1949), pp. 390-392.

TEAM PROBLEM I

A SOLID EXPANDS WHEN HEATED

October 12, 1956

PROBLEM:	To show that heating causes a wire to stretch.
PRESENTATION:	Materials are placed on a table.
MATERIALS:	Candle and holder / Three feet of copper wire / A rock / A match / A crane
RESULTS:	Keep a record of what happened in the blank-book on the table. Report results to the class.

ANECDOTAL RECORD

Jean, Freida, Harriett, and Garland faced Science Problem I today. Phil was being tested in Reading because of a previous absence and did not take part in the experiment. The tape recording was poor because the speaker was not adjusted well.

The group worked as a team. Harriett decided to write down their conclusions.

The materials presented were taken for granted. The wire was presumed to be exactly three feet long. (It actually was longer than three feet.) The wire was attached to the top of the crane. The rock held it at the bottom with a child's hand holding the rock. Candle heat was applied. A ruler was borrowed from a classmate for measuring. Here are their comments: (1) I think it's longer. (2) It probably stretched some.

When told that the ruler was not a part of the material allowed in the original equipment, the team agreed that the wire got longer anyway. They returned to their desks to discuss their findings with the class.

The ensuing discussion led the class to say that no conclusive proof had been given. The committee said they felt they were right in saying that the wire was longer, but the class could see no proof.

Freida took no part in the discussion, but listened well. Finally she said, "We should have tied the rock to the crane with the copper wire. The rock should just miss touching bottom. Apply the candle heat to the wire, and the weight of the rock will make the rock stop swinging and hit bottom."

The class applauded and accepted her conclusion. They decided to try it at the next science period.

CHILDREN'S REACTION

We tied the wire on the crane. Then we put the candle under it. We made sure the wire was tight. We began to wait for the results.

When we finished, it had stretched. We had proved it.

Jean
Harriett
Freida
Garland

THE OBSERVER'S REACTION

Criteria for judging traits was set up:

4. Rare
3. Superior
2. Very good
1. Fair

The observers felt that at the end of the experiment in May they would be more efficient in trait judgment than they are today.

TEAM PROBLEM II

HEATED WATER MOVES ABOUT

October 19, 1956

PROBLEM: Making heated water move about.

MATERIALS:
1 deep glass dish with cold water
1 ink bottle
1 cap or cork for ink bottle
1 cup of warm water
Some coloring matter (red ink)
1 pot holder for lifting hot pan

RESULTS: Keep a record of what happened in the science blankbook. Did the water move? Why?

ANECDOTAL RECORD

The group talked about putting red ink in the cold water and other ideas. None of these were accepted by the team.

Freida remembered a science book from which the teacher had read to the class. She looked for it among the teacher's own books and found it on page 36 of Adventuring In Science, by Gerald S. Craig and Katherine E. Hill. She read to the group from the book and they experimented according to the instructions.

The team of five had a conference with the teacher and two observers.

"How well did we think today?" asked the teacher.

The team came to the conclusion that the thinking this week was not as good as the previous week. We had solved the problem in ten minutes but we had done no original thinking. Everyone agreed that good thinking was better than solving a problem by using a book to do it quickly.

On the next problem, the team agreed not to use a book for help until after the first day anyway.

THE OBSERVERS' REACTION

Every problem would not give an opportunity to exhibit all the traits mentioned on the chart evaluation; therefore, blanks would occur where there was an absence of opportunity or a lack of trait shown.

The observers felt that the team had taken a forward step in deciding not to use the book so soon.

TEAM PROBLEM III

AIR IS ALWAYS CHANGING

October 25, 1956

PROBLEM: Wind is air in motion.

MATERIALS: A wooden box from which the front has been cut away and replaced with a glass pane.
Two circular holes are cut in the top of the box.
Two lamp chimneys are placed over the holes.
Two lighted candles. A rag. A match.

RESULTS: Keep a record of what happens for a class report.

ANECDOTAL RECORD

The team talked about the problem at random. They had no planned procedure. There was danger from the fire without proper planning. Fear of fire danger was so much a part of them that it hindered thinking. They knew the rag should burn. The cardboard holding the lamp chimney in place did burn. The teacher put it out and suggested they plan more carefully with the use of the candle.

The class watched from time to time. Many were also interested in the class team which was attempting to solve Class Problem I. It was similar in nature to the original team's problem.

The problem was equally difficult to both teams. The team of five decided to place the rag over the top of the heated chimney. It wouldn't burn.

The team said, "We are not thinking very much."

False attempts to succeed led to a desire to stop. Talking it over, the team decided to think a bit about the problem and try again another day. This idea suited the class group also.

The next day, the teacher asked the class, "What do we know about heating and cooling air?"

"Air rises when heated," said one.

"Air sinks when cooled," said another.

"How can you prove it?" asked the teacher.

Bob heated water and placed a long-necked pyrex bottle, capped with a balloon, into it. The balloon inflated quickly. The class laughed. He placed the bottle into a bowl of ice. The balloon deflated slowly, finally being sucked into the neck of the bottle.

"This proves the expansion and contraction of air when it is heated and cooled," said Bob.

"It is the answer to our problem of yesterday," said Harriett.

"One chimney is to heat and the other is to cool," said Bob.

"What will the rag do?" asked Jean.

"How could we show these ideas in the box?" asked the teacher.

"Smoke will do it," said Garland.

"Yes, it will," said the teacher. "This experiment will demonstrate heating by convection."

"Let's do it," said the class, and they did. (Reynolds wrap was used between the candles and the cardboard box top to prevent fire hazard.)

CHILDREN'S REACTION

Air is always changing.

We lit the candle and put it in the bottom of a box. We put cardboard on top with two holes in it. We put two lamp chimneys over the holes.

We took a long time. We didn't know what to do, but we didn't give up. We will think and try again.

Jean
Harriett
Phil
Freida

OBSERVERS' REACTION

The three observers felt that the children showed persistence when they decided to think and try again another day.

The teacher realized the team had reached the limit of its resources in solving the problem. She decided to take over and help.

The teacher and observers noted the class reaction in wanting to be a part of the problem.

CLASS PROBLEM I

AIR IS ALWAYS CHANGING

PROBLEM: Wind is air in motion.

MATERIALS:
1 pyrex plate
1 lamp chimney
1 candle
1 match
4 blocks of wood
1 thin piece of wood

RESULTS: Keep a record for class use.

Jeanne, Emmett, Gentry, and Alice were chosen by the class to attempt to solve this problem. It was done while the experimental team was attempting to solve its own problem. Gail was chosen to listen and make a record of what happened.

TEAM PROBLEM IV

THE EFFECTS OF HEATING ON WATER AND SOIL

November 2, 1956

PROBLEM:	Does water or soil heat faster? Does water or soil cool faster?
MATERIALS:	A gooseneck lamp with a 60 watt bulb 1 pound of water — 2 tin dishes 1 pound of soil — 1 crane 1 thermometer — 1 bit of string A watch with a second hand
RESULTS	Record heating temperatures and cooling temperatures every three minutes. Record for the class your plan of action.

ANECDOTAL RECORD

The children handled the material and talked about it. They used the clue of the watch and three minutes of testing of the heat. How to use the thermometer to the best advantage was finally solved by suspending a string from the crane and attaching the thermometer to it. They decided to heat the soil three minutes and the water three minutes and record the heat rise.

Garland was absent. The group appeared to miss his contribution.

OBSERVERS' REACTION

The observers felt that the children needed help in learning how to plan together, selecting the best plan, and carrying through on the plan.

The children needed help in experiences with heat.

CLASS PROBLEM II

PROBLEM: Does water evaporate quickest in cold air or warm air?

MATERIALS:			
	2 wet cloths	Scotch tape	Warm water
	1 yardstick	2 clothes pins	2 pyrex dishes
	1 dowel rod	2 bowls	String
	1 box	Ice	

CLASS REACTION

This interest led to many experiments with fuels and fire and heat.

CLASS RECORD FOR NOVEMBER 20

SOIL

We tried to heat the soil for fifteen minutes today. The soil was 66 degrees when we started. At the end of three minutes it was 69 degrees. At the end of the second three minutes it was 75 degrees; then 81 degrees; then 83 degrees; then 83 degrees.

It rose in temperature 17 degrees in fifteen minutes.

When the soil began to cool, it was 79 degrees. In three minutes it was still 79 degrees. The next three minutes it cooled to 77 degrees; then 76 degrees; then still 76 degrees. In fifteen minutes the soil cooled 3 degrees.

WATER

The water was 75 degrees in temperature when we turned on the gooseneck lamp. After three minutes of heating, it was 76 degrees; then 77 degrees; then 78 degrees; then 78 degrees; then 79 degrees. Altogether it heated 4 degrees in fifteen minutes.

In the fifteen minutes of cooling, the water registered 79 degrees, 79 degrees, 79 degrees, 78 degrees, 78 degrees. It cooled 1 degree in fifteen minutes.

This experiment shows soil heats and cools faster. Water heats and cools slower.

Ellen
Emmett
Tom
Gail

CLASS PROBLEM IV

One day Tom wanted to know if the scientific method of thinking could be used in other fields. The teacher presented the class with the following problem.

LEARNING EXPERIMENT

Is it possible to use the scientific method in subjects other than science?

PROBLEM:	Can memory be improved?	
MATERIAL:	A learner's code Space to test code use	Pencil Stop watch
RESULTS:	Plan how to use this material to prove or disprove that memory can be improved. Keep a record of how you can use the code.	

ANECDOTAL RECORD

A good discussion about how to use the code took place. Many plans were suggested and rejected. The plan that met with class approval was: "Give the test three times, allowing one-half minute to transfer the code at the top of the page to the boxes below. Count the score for each trial. Note the changes on each score. Draw conclusions."

This plan was followed. The results showed that some stayed about the same on each trial, some improved on one of the three trials, and many made a steady improvement with each new trial. A class secretary tabulated the results of each trial on the blackboard.

The class felt that the scientific method could be used in ways other than science. In this experiment, it appeared that memory could be improved with practice.

TEAM PROBLEM V

A HOMEMADE ANEROID BAROMETER

January 4, 1957

PROBLEM: To construct a device that will register atmospheric pressure but will also register changes of temperature due to the expansion of air inside the bottle.

MATERIALS:

A wooden base	Some string
A vertical stick	A straw
Nails and a hammer	Some glue
A quart bottle	A piece of white paper
A pair of scissors	A pencil
Dictionary for hard words	
A rubber diaphram that is 6" x 6"	
A ruler	

RESULTS: Plan for your results carefully. Keep a clear record of what you plan and do for the class.

ANECDOTAL RECORD

The committee inspected the materials. They discussed various plans of action. In their discussion, Garland, Jean, and Freida mentioned the correct ideas for the solution of the problem but didn't realize it.

The committee decided to adjourn and think over the solution, meet again, and make plans for solving the problem.

CHILDREN'S REACTION

First we looked over our materials. Then we thought of some ideas as to how to make an aneroid barometer.

Jean and my idea is to put the bottle on the platform, and put a straw in the bottle, then put the rubber on the top of the bottle and tie it with a string. We will then put the stick on top of the bottle and put a nail through it, so it will go through the straw. The stick will then balance and it will measure pressure and the straw will move up and down.

Freida.

My plan is to place the bottle on the platform and make a little pen with nails so it won't slip. Place the rubber on the top of the bottle and tie it with a string then glue the straw to the rubber. Next nail the stick to the side of the platform and then glue the paper to the stick and the pressure of the air will force down on the rubber and make the straw go down and mark the place on the stick.

Garland.

OBSERVERS' REACTION

The observers felt that the committee had grown to the point where they were ready to receive their problem before they met together. This would allow time for thinking and planning alone.

CLASS REACTION

The class was interested in keeping an account of the air pressure. This led to a study of air masses and weather. Daily weather records were kept during January.

Snow and clouds furnished art opportunities which the class enjoyed.

TEAM PROBLEM VI

A HOMEMADE STEAM TURBINE

PROBLEM: To make power that will turn a paper wheel.

MATERIALS:

A candle	Some clay
A match	A paper 6" by 6"
Some water	A ruler
A pyrex test tube	A pair of scissors
A test tube holder	A dowel rod
An eye dropper glass	A hat pin

RESULTS: Discuss and record plans. Keep a record for the class.

ANECDOTAL RECORD

The group planned to heat the water to create steam power. They experimented; then planned their windmill. They omitted the eye dropper.

Freida discovered its use: to direct the steam power toward the propeller. She and Garland filled the air gap between the top of the test tube and the eye dropper with clay.

These four children really planned and worked this problem out together. Their cooperation as a group was excellent.

Jean was absent today.

CHILDREN'S REACTION

Plans and Records

Meaning of turbine: An engine whose central driving shaft is fitted with a series of winglike projections, whirled around by the pressure of water, steam, air, etc.

This is the plan of Phil, Garland, Freida, and Harriett, (myself). This is also the record, because the plan is correct. Here is the plan:

We took a dowel rod and stuck it in a ball of clay. Then we made a propeller as you call it, out of a 6" by 6" piece of paper and a hat pin. Then we took some clay and put it on top of a pyrex test tube with a hole in the clay. In the hole in the clay we stuck an eye dropper glass which steam would be sent through. The pyrex test tube was half full of water. Then we lit a candle and put it under the test tube. The water was heated and the steam came through the eye dropper and made the propeller turn around.

We will do this same thing over with lighter paper for the propeller.

Respectfully yours,

Harriett
Phil
Freida
Garland

OBSERVERS' REACTION

The observers noted the cooperative group effort. They felt this problem was somewhat easier to solve than several preceding ones.

CLASS REACTION

Tom, Bob, Phil, and Garland brought toy turbines to show and demonstrate to the class. Morgan brought his electric engine.

This interest led to a detailed study of simple machines: inclined plane, lever, wheel and axle, and pulleys. Many models were made and demonstrated in the room and in other rooms of the building.

TEAM PROBLEM VII

THE PULL OF GRAVITY

February 2, 1957

PROBLEM: Make a model of the surface of the earth, showing hills and mountains. Show how water carries soil and sand from our hills and mountains and changes the surface on our model of a part of the earth.

MATERIALS:

A sand table	A hammer
Sand	A spike
Humus	Water
Clay	A hose with a spray
A large can	A clothes pin

RESULTS: Plan to solve the problem. Distribute the responsibility. Do the work. Record what happens for the class.

ANECDOTAL RECORD

Freida had a good plan in the beginning. She is willing to listen to the ideas of others and does not insist on her own solution. She participates and shares.

Harriett gets an idea and does not listen well to what others say. She is argumentative and stubborn.

Garland seems to be master of ceremonies today, asking questions and making suggestions that smooth troubled waters.

Jean is absent.

Phil finally offers a plan that everyone accepts, but it was not his original idea.

Harriett needs help in her social relations.

This planning took fifteen minutes.

TEAM PROBLEM VIII

LIGHTING A PLAY CITY

February 14, 1957

PROBLEM: Show some of the principles of electricity as you use poles and wires to light a play city.

MATERIALS:

Electric light poles	Knife
Wooden bases	Insulation tape
Wooden cross beams	Electric switch
Nails and hammer	2 dry cell batteries
Insulated wire	Flashlight bulbs and sockets

ANECDOTAL RECORD

Freida, Garland, and Phil had a real interest in this problem. Neither Jean nor Harriett remained active participants for any length of time. Freida asked to see again the film strip about what makes an open and closed circuit. The three children felt that they needed clarification about which were the negative and positive poles on the dry cell battery.

They decided to try to illuminate one light before attempting many lights. They devised a closed circuit quickly.

CLASS REACTION

This led to connecting a class door bell, a homemade magnetic crane, renewed interest in magnets, a question and answer board rigged up with electrical current.

Through experimentation, we learned that electricity is made in three ways: (1) by rubbing certain materials together, (2) by the use of chemicals, and (3) by generators.

Mr. Charles D. Moore of the Chesterfield plant of the Virginia Electric and Power Company visited our class to discuss generated electricity.

TEAM PROBLEM IX

CONSTRUCTION OF A TELEGRAPH SET

March 7, 1957

PROBLEM: Make a telegraph sender. Make a telegraph receiver. Send and receive messages from the hall to our room.

MATERIALS:

(For Sender)	(For Receiver)
1 metal strip 4"x$\frac{1}{8}$"	1 block of wood, 6"
Hammer and Nails	1 block of wood, 5"
Insulated wire	1 iron strap hinge
A dry cell battery	Insulated wire
1 small square of metal ($\frac{1}{8}$"x$\frac{1}{4}$")	

RESULTS: Record what you want to know, what you do, what you need, and what you find out.

ANECDOTAL RECORD

Phil had worked on a telegraph set with some boys in his neighborhood. Garland had a cousin who was an active radio "Ham." Both of these children were able to solve this problem easily because of their background.

Freida was an active participant. She seemed to enjoy trying to solve the problem. Jean listened but couldn't offer too much help. She had just returned to school after an attack of virus. Harriett offered to write up the project.

All the children asked to see again the film strip about Electro-magnets.

TEAM PROBLEM X

WATER RISES IN SOIL

March 21, 1957

PROBLEM:	Does water rise to or near the surface of the soil?

MATERIALS:	Soil and Sand	Cloth
	Lamp Chimney	String
	Glass	Wedges of Wood
	Water	Clock

RESULTS: Plan what to do. Record what happens.

ANECDOTAL RECORD

The group was alert and active. They were full of ideas. Each child participated.

The big end of the lamp chimney was used, so the children asked permission to discard the wedges of wood.

There was a quick solution. Dr. Edward F. Overton from the University of Richmond was the guest of the class. He was invited to watch us dance for him. He observed us at work and at play.

CLASS PROBLEM VIII

KEEPING WATER IN SOIL

PROBLEM: Will a cover over soil that is moist keep water from evaporating from it?

MATERIALS:	Soil	Covering for soil
	Water	Garden tools

RESULTS: Plan what to do. Record what happens in covered soil and uncovered soil. Let them stand one week.

Alice and Dianne were chosen by the class to solve this problem. Many children made their own problems and brought their own material to be used in the solution of their problems.

TEAM PROBLEM XI

MAKING SEDIMENTARY ROCK

March 28, 1957

Plan a section of the earth that might have been formed by sediment. Indicate layer formation. Put into the bands a V-shape that a river might have cut through the layers after its formation.

Plan to paint your creation after it dries.

Top it with a layer of top soil. Seed it. Make trees of twigs, newspaper wads, string, and paint.

Plan to display it.

ANECDOTAL RECORD

In the planning, each child took a part and was responsible for completing it. They planned quickly and easily.

In carrying out the plan, the clay was too dry for easy use. We decided to wet it and wait. Each child was to bring an old shirt to be used as an apron to protect clothing.

TEAM PROBLEM XII

MAKING A FIRE EXTINGUISHER

PROBLEM: How to mix water and vinegar in a jar to create pressure enough to force water from it.

MATERIALS:

- 1 bottle
- 1 one-hole stopper
- 1 glass tube
- 1 Teaspoon
- A mixture of half water and half vinegar
- String
- Tissue Paper

RESULTS: Record your plans. Test the results by inverting the bottle creating a fire extinguisher. Do this outdoors.

ANECDOTAL RECORD

Phil was the leader in this experiment from the beginning. His plan was so clear and correct that the group accepted it without question.

Each child had a part in the execution of the plan. When it was completed, the class was invited to the school yard to watch the experiment.

The north side of the building was chosen as the safest location for the fire. Mike took newspaper and matches to make the fire. Charles offered much practical advice about how the experiment should be executed because he said he had made a fire extinguisher at home one afternoon.

As a result of this experiment, the class solved many problems about the use of acid and alkali. The one most enjoyed was two batches of biscuit; one with baking powder and one without it. Butter was provided. Everyone enjoyed eating biscuits that rose and biscuits that didn't rise. Eating was so pleasant that flat biscuit wasn't important!

Table IX shows the results of the time sampling of traits for the scheduled observations. The three observers were not able to be present at all twelve situation tests; hence, the difference in the denominator of the fractions. The numerator is the sum of the scores of the check list set up by the observers in problem solving situation I.

TABLE IX

TOTAL SCORES AND TOTAL NUMBER OF OBSERVATIONS MADE BY OBSERVERS OF TRAITS OF EXPERIMENTAL TEAM

TRAITS		JEAN	GARLAND	HARRIETT	PHIL	FREIDA
CURIOSITY	H	23/9	31/10	31/11	22/9	34/11
	P	21/8	21/8	23/9	18/7	26/9
	B	18/6	21/7	19/7	15/5	21/7
CREATIVE IMAGINATION	H	15/9	17/10	23/11	14/9	20/11
	P	17/8	18/8	19/9	11/7	23/9
	B	11/6	9/7	12/7	9/5	10/7
MANUAL DEXTERITY	H	9/9	14/10	12/11	17/9	22/11
	P	12/8	16/8	10/9	17/7	20/9
	B	8/6	11/7	9/7	9/5	17/7
PLANNING ABILITY	H	19/9	21/10	19/11	22/9	32/11
	P	17/8	20/8	15/9	11/7	24/9
	B	15/6	15/7	12/7	12/5	18/7
PERSISTENCE	H	18/9	25/10	24/11	22/9	26/11
	P	20/8	20/8	22/9	18/7	24/9
	B	11/6	14/7	13/7	11/5	13/7
ABILITY TO SPOT A PROBLEM AND DETECT INCONSISTENCIES	H	18/9	24/10	19/11	20/9	29/11
	P	19/8	20/8	17/9	13/7	23/9
	B	10/6	13/7	11/7	10/5	16/7

H = Observer
P = Observer
B = Observer
Numerator = Total Score
Denominator = Number of times observered by scorer

Table X shows the average made by each team member on the traits listed on the check list. Similarity of observer rating can be noted.

TABLE X

RESULTS FOR OBSERVER AVERAGES OF TRAIT DEGREE
FOR EXPERIMENTAL TEAM

TRAITS		JEAN	GARLAND	HARRIETT	PHIL	FREIDA
CURIOSITY	H	2.56	3.10	2.82	2.44	3.09
	P	2.63	2.62	2.56	2.56	2.78
	B	3.00	3.00	2.71	3.00	3.00
CREATIVE IMAGINATION	H	1.67	1.70	2.09	1.56	1.82
	P	2.13	2.25	2.11	1.56	2.56
	B	1.83	1.29	1.71	1.80	1.43
MANUAL DEXTERITY	H	1.00	1.40	1.09	1.89	2.00
	P	1.50	2.00	1.11	2.43	2.22
	B	1.34	1.57	1.29	1.80	2.43
PLANNING ABILITY	H	2.11	2.10	1.72	2.44	2.91
	P	2.13	2.50	1.67	1.56	2.67
	B	2.50	2.14	1.71	2.40	2.57
PERSISTENCE	H	2.00	2.50	2.18	2.44	2.36
	P	2.50	2.50	2.44	2.56	2.67
	B	1.83	2.00	1.86	2.20	1.86
ABILITY TO SPOT A PROBLEM AND DETECT INCONSISTENCIES	H	2.00	2.40	1.72	2.22	2.64
	P	2.38	2.50	1.89	1.85	2.56
	B	1.67	1.86	1.56	2.00	2.29

H = Observer
P = Observer
B = Observer

CHAPTER V

CONCLUSIONS

Results of the Science Testing

The problem solving situation test is a challenging method of instruction in science because (1) the Experimental Class made significant growth in science knowledge, and (2) the Experimental Team made more significant growth in science knowledge.

The proof of these two statements is found in a study of the results of the science tests. Table XI contains the result of the science test given to the Experimental Class in May, 1957.

TABLE XI

RESULTS FOR ELEMENTARY SCIENCE TEST, FORM A, FOR EXPERIMENTAL CLASS, GIVEN IN MAY, 1957 GRADE 6 HIGH, DATE TESTED 5-20-57

PUPIL'S NAME		PARTS					SCORE
		I	II	III	IV	V	
1.	Hagen	24	24	27	25	17	117
2.	Haynes	24	24	27	25	17	117
3.	Fromm	23	24	27	24	17	115
4.	Prout	23	21	27	22	18	111
5.	Martin	24	22	25	21	17	109
6.	Hill	20	22	25	25	16	108
7.	Schaaf	22	22	25	24	15	108
8.	Downer	24	20	24	22	17	107
9.	South	23	20	23	22	18	106
10.	Merriman	23	19	24	24	15	105
11.	Dean	21	20	21	25	17	104
12.	Moore	21	20	25	23	15	103
13.	Murphy	19	20	26	23	15	103
14.	Clyborne	19	22	25	21	16	103
15.	Hamilton	21	18	25	23	15	102
16.	Bengel	22	17	24	22	17	102
17.	Booth	21	20	21	22	17	101
18.	Alexander	22	17	26	23	13	101
19.	Taylor	21	20	23	23	14	101
20.	Terrell	21	19	21	24	16	101
21.	Williams	22	18	22	23	15	100
22.	Gentry	23	19	21	20	16	99
23.	Lucy	20	18	20	23	18	99
24.	Thompson	19	18	22	22	15	96
25.	Barrons	22	23	19	17	15	96
26.	Jones	19	19	25	16	13	92
27.	Dixon	19	17	23	19	13	91
28.	Boothe	21	19	22	15	13	90
29.	Kerr	16	11	21	22	13	83
30.	Gordon	17	16	17	15	15	80
31.	Morgan	21	17	16	13	13	80
32.	Metzger	11	15	14	18	13	71
33.	Linkous	12	15	18	13	11	69
34.	Wade	15	10	10	11	8	54

Table XII offers a comparison of the results of the science tests given to the Experimental Class in September, 1956, (See Table I, page 15), and May, 1957. An average improvement of almost 13 points was made.

TABLE XII

RESULTS FOR COMPARISONS OF ELEMENTARY SCIENCE TESTS, FORM A, GIVEN TO EXPERIMENTAL CLASS IN SEPTEMBER, 1956, AND MAY, 1957

PUPIL'S NAME	SEPTEMBER	MAY	PLUS	MINUS
1. Fromm	110	115	5	
2. Haynes	105	117	12	
3. Prout	105	111	6	
4. Hill	102	108	6	
5. Hagen	100	117	17	
6. Lucy	97	99	2	
7. Taylor	97	101	4	
8. Martin	96	109	13	
9. Alexander	94	101	7	
10. South	94	106	12	
11. Murphy	93	103	10	
12. Hamilton	93	102	9	
13. Merriman	93	105	12	
14. Booth	92	101	9	
15. Clyborne	91	103	12	
16. Gentry	91	99	8	
17. Dean	89	104	15	
18. Terrell	86	101	15	
19. Metzger	85	71		14
20. Schaaf	84	108	22	
21. Moore	84	103	19	
22. Boothe	83	90	7	
23. Bengel	83	101	18	
24. Thompson	75	96	21	
25. Downer	74	107	33	
26. Gordon	72	80	8	
27. Jones	71	91	20	
28. Barrons	71	96	25	
29. Kerr	70	83	13	
30. Dixon	70	90	20	
31. Morgan	68	80	12	
32. Williams	66	100	34	
33. Linkous	65	69	4	
34. Wade	32	54	22	

Total Plus = 452
Total Minus = 14
458

12.88
34) 438.00
34
98
68
300
272
280
272
8

Average Improvement = 12.88

Table XIII gives the result of the science test given to the Control Class in May, 1957.

TABLE XIII

RESULTS FOR ELEMENTARY SCIENCE TEST, FORM A,
GIVEN TO CONTROL CLASS IN MAY, 1957
GRADE 6 HIGH, DATE TESTED 5-21-57

PUPIL'S NAME	PARTS I	II	III	IV	V	SCORE
1. Buford	22	24	25	24	18	113
2. Failing	21	21	24	24	17	107
3. Shepherd	19	22	24	23	15	103
4. Williams	18	21	25	22	16	102
5. Gunn	19	19	24	25	15	102
6. Berkeley	21	20	23	23	15	102
7. Spurr	20	19	25	22	15	101
8. Ritchie	22	19	23	20	16	100
9. Hanson	19	21	25	21	13	99
10. Hicks	21	19	21	22	15	98
11. Mefford	22	15	20	24	15	96
12. Cleaton	22	20	25	15	14	96
13. Heaton	19	15	24	20	16	94
14. Garza	16	18	22	23	15	94
15. Crawley	14	19	23	22	15	93
16. Breedon	15	19	22	23	14	93
17. Shinault	16	18	24	21	12	91
18. Atkins	15	16	22	18	16	87
19. Roberts	16	14	21	20	15	86
20. Pollard	18	18	20	13	16	85
21. Tuck	17	17	15	20	13	82
22. Landrum	14	15	19	21	12	81
23. Carroll	17	19	12	22	11	81
24. Newsome	16	16	16	21	11	80
25. Bareford	13	12	23	21	11	80
26. Craven	15	12	19	16	13	75
27. Duff, O.	12	13	19	14	16	74
28. Robertson	8	15	16	15	16	70
29. Lindsey	9	12	15	11	13	60
30. Duff, D.	10	11	12	4	16	53

Table XIV records the results of the science tests given to the Control Class in September, 1956, (Table VI, page 25), and May, 1957. The average improvement was 8.47 points.

TABLE XIV

RESULTS OF COMPARISONS FOR ELEMENTARY SCIENCE TESTS, FORM A, GIVEN TO CONTROL CLASS IN SEPTEMBER, 1956, AND MAY, 1957

PUPIL'S NAME	SEPTEMBER	MAY	PLUS	MINUS
1. Buford	109	113	4	
2. Gunn	103	102		1
3. Hanson	101	99		2
4. Failing	99	107	8	
5. Cleaton	98	96		2
6. Shepherd	96	103	7	
7. Hicks	94	98	4	
8. Berkeley	92	102	10	
9. Heaton	92	95	3	
10. Crawley	88	93	5	
11. Ritchie	88	100	12	
12. Williams	88	102	14	
13. Spurr	88	101	13	
14. Harvey	87	Moved away		
15. Mefford	87	96	9	
16. Shinault	86	91	5	
17. Garza	85	94	9	
18. Roberts	81	86	5	
19. Breeden	81	93	12	
20. Landrum	77	81	4	
21. Newsome	76	80	4	
22. Tuck	73	82	9	
23. Bareford	72	80	8	
24. Atkins	71	87	16	
25. Craven	67	75	8	
26. Robertson	65	70	5	
27. Duff, O.	65	74	9	
28. Carroll	58	81	23	
29. Lindsey	54	60	6	
30. Pollard	53	85	32	
31. Nunnally	48	Moved away		
32. Duff, D.	38	53	15	

Total Plus = 259
Total Minus = 5
254

```
        8.466
30) 254.000
    240
     140
     120
      200
      180
       200
       180
        20 = 2/3
```

Average Improvement = 8.47

Members of the Department of Research of the Richmond Public Schools made a test record of these results to ascertain whether the improvement was significant. The result was:

	N	$\bar{X}$	ΣX	ΣX^2	s^2	t
Experimental Class	34	12.9	438	8378	82.9	2.2
Control Class	30	8.5	254	3570	48.9	

This test indicates that the improvement made in science knowledge by the Experimental Class was not accidental, but it was due to the teaching methods used.

Table XV states the results on the science tests given in September, 1956, and May, 1957, for the Experimental Team and the Control Team. The amount of difference in the scores of each is noted and the average improvement of each team is given.

Members of the Research Department of the Richmond Public Schools made a test record of these results to note significant growth. The results were:

	N	$\bar{X}$	ΣX	ΣX^2	s^2	t
Experimental Team	5	13.8	69	971	4.7	4.1
Control Team	5	4.8	24	190	18.7	

The amount of improvement of the Experimental Team over that of the Control Team was not due to chance but to the method of teaching used.

TABLE XV

A COMPARISON FOR RESULTS OF TEAM OF FIVE
IN THE EXPERIMENTAL CLASS AND CONTROL CLASS ON SCIENCE TEST
GIVEN IN SEPTEMBER, 1956, AND MAY, 1957
(SPECIAL SCIENCE TEAM)

Experimental Team

Merriman——Most Popular Child
Hagen——High I. Q.
Haynes——A High Score on Science Test
Kerr——Middle Score I. Q.
Terrell——Middle Score on Science Test

Science Scores

	September, 1956	May, 1957	
Merriman	93	105	+ 12
Hagen	100	117	+ 17
Haynes	105	117	+ 12
Kerr	70	83	+ 13
Terrell	86	101	+ 15

Average Improvement 13.8

Control Team

Crawley——Most Popular Child
Buford——High I. Q.
Hanson——A High Score on Science Test
Bareford——Middle Score I. Q.
Garza——Middle Score on Science Test

Science Scores

	September, 1956	May, 1957	
Crawley	88	93	+ 5
Buford	109	113	+ 4
Hanson	101	99	− 2
Bareford	72	80	+ 8
Garza	85	94	+ 9

Average Improvement 4.8

Results of the Social Relation Testing

The Experimental Class grew more in social behavior than the Control Class. In proof of this statement, the Russell Sage Social Relation Test is offered.[31] The test took the form of a situation test. It was developed with the intent of evaluating the nature and quality of two aspects of elementary school children: (1) cooperative group planning and procedures, and (2) cooperative group action.

During the test, two observers recorded class behavior. This data was transferred to numerical scores which rank the class in the two areas mentioned.

Tables XVI and XVII show the result of the Planning Stage of the Russell Sage Social Relation Test for both the Experimental Class and the Control Class in September, 1956, and May, 1957.

The Experimental Class improved more than the Control Class in its ability to plan together.

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[31] Dora E. Damrin, Russell Sage Social Relation Test, Educational Testing Service, (Princeton, New Jersey: December, 1955).

Tables XVIII and XIX give the record of the result of the Russell Sage Social Relation Test in Operation Stage for both the Experimental Class and the Control Class in September, 1956, and May, 1957. The Experimental Class made improvement, and the Control Class did not improve, but went backward.

TABLE XVI

RESULTS FOR RUSSELL SAGE SOCIAL RELATION TEST IN PLANNING GIVEN TO BOTH THE EXPERIMENTAL CLASS AND CONTROL CLASS IN SEPTEMBER, 1956, AND MAY, 1957

Scoring Profile Sheet—Planning Stage—Grade 6
Examiner—1, Observers—2, Problems—3.

(September, 1956) EXPERIMENTAL	CONTROL		(May, 1957) EXPERIMENTAL	CONTROL
		I Involvement		
Verbal		1 = None	Verbal	
2.3	1.8	2 = Little	3.4	2.0
Non-Verbal		3 = Half	Non-Verbal	
4.0	3.5	4 = Most	4.2	3.5
		5 = All		
		II Communication		
		1 = No Contribution		
Direction		2 = To Examiner	Direction	
3.0	3.0	3 = To Near Neighbor	4.0	4.0
		4 = To Each Other		
		5 = To Each Other & Examiner		
		III Outcomes - Statement of Plan		
		1 = All at Once		
		2 = Unorganized		
4.0	4.7	3 = Leader Only	5.0	4.3
		4 = Organized Groups		
		5 = Leader-Groups or Construction Group		
TOTAL			TOTAL	
13.3	13.0		16.6	13.8
AVERAGE			AVERAGE	
3.3	3.3		4.2	3.5

Examiner Behavior:	Experimental	Control
Prods	4 2 0	2 0 2
Discipline	0 0 0	0 0 0

TABLE XVII

DETAILS OF SUMMARY ON RUSSELL SAGE SOCIAL RELATION TEST IN PLANNING GIVEN TO BOTH EXPERIMENTAL CLASS AND CONTROL CLASS IN SEPTEMBER, 1956, AND MAY, 1957

EXPERIMENTAL		CONTROL
	September	
2.3		1.8
4.0		3.5
3.0		3.0
4.0		4.7
4)13.3	Total	4)13.0
3.3	Average	3.3
	May	
3.4		2.0
4.2		3.5
4.0		4.0
5.0		4.3
4)16.6	Total	4)13.8
4.2	Average	3.5
+.9	Improvement	+.2

TABLE XVIII

RESULTS FOR RUSSELL SAGE SOCIAL RELATION TEST IN OPERATION STAGE GIVEN TO BOTH EXPERIMENTAL CLASS AND CONTROL CLASS IN SEPTEMBER, 1956, AND MAY, 1957

Examiner--1, Observers--2, Grade--6, Problems--3

(September, 1956) EXPERIMENTAL	CONTROL		(May, 1957) EXPERIMENTAL	CONTROL
		I Involvement		
4.6	4.5	(Builders) 1 = Teacher Reprimand 2 = Whining, Complaining 3 = Rough & Boisterous 4 = Tense & Excited 5 = Quiet & Intent	4.8	4.5
3.7	4.3	(Non-Builders) 1 = Impeding (Heckling) 2 = Noisy (Not-Focused) 3 = Quiet, Socializing 4 = Occasional Attention 5 = Focused, Attentive	4.0	3.5
3.0	4.8	II Efficiency in Following Plan 1 = Not Followed 2 = 3 = Modified 4 = 5 = Followed	4.9	3.4
3.3	4.0	III Success	3.7	4.3
14.6	17.6	Total	17.4	15.7
3.7	4.4	Average	4.4	3.9

	Experimental			Control		
Time	5	9	8	6	5	5
Errors	1	1	1	0	1	1
	6	10	9	6	6	6
TOTALS	4	3	3	4	4	4

5 point scale:

Over 15	1
12 to 15	2
8 to 11	3
4 to 7	4
0 to 3	5

TABLE XIX

DETAILS OF SUMMARY ON RUSSELL SAGE SOCIAL RELATION TEST IN OPERATION STAGE GIVEN TO BOTH EXPERIMENTAL CLASS AND CONTROL CLASS IN SEPTEMBER, 1956, AND MAY, 1957

Experimental		Control
	September	
4.6		4.5
3.7		4.3
3.0		4.8
3.3		4.0
14.6	Total	17.6
3.7	Average	4.4
	May	
4.8		4.5
4.0		3.5
4.9		3.4
3.7		4.3
17.4	Total	15.7
4.4	Average	3.9
	Improvement	
+.7		-.5

Results of Observer Rating of Team Behavior Traits

The behavior traits for the Experimental Team of five were measured. There was much similarity of observer rating and the degree of growth was noted. Tables XX and XXI show this growth.

TABLE XX

RESULTS FOR THE SUM OF THE SCORES
OF THE FIRST THREE SITUATION TESTS AND
THE LAST THREE SITUATION TESTS MADE BY OBSERVERS
(TOTAL SCORES AND OBSERVATIONS)

TRAITS		JEAN	GARLAND	HARRIETT	PHIL	FREIDA
CURIOSITY	A	18/8	17/6	16/8	6/5	16/8
	B	22/7	20/7	24/7	23/7	25/7
CREATIVE IMAGINATION	A	18/8	11/6	10/8	3/5	10/8
	B	11/7	8/7	15/7	11/7	15/7
MANUAL DEXTERITY	A	13/8	11/6	8/8	10/5	13/8
	B	10/7	12/7	12/7	16/7	15/7
PLANNING ABILITY	A	13/8	12/6	8/8	5/5	12/8
	B	22/7	16/7	16/7	18/7	26/7
PERSISTENCE	A	11/8	4/6	10/8	1/5	7/8
	B	19/7	16/7	19/7	19/7	19/7
ABILITY TO SPOT A PROBLEM AND DETECT INCONSISTENCIES	A	13/8	8/6	9/8	3/5	8/8
	B	16/7	18/7	14/7	16/7	18/7

A = Sum of first three team problem scores.
B = Sum of last three team problem scores.
Numerator = Sum of Scores.
Denominator = Number of times scored by observer.

TABLE XXI

RESULTS FOR THE AVERAGES FROM OBSERVERS
OF THE SCORES OF THE FIRST THREE SITUATION TESTS AND
THE LAST THREE SITUATION TESTS SHOWING DEGREE OF IMPROVEMENT
(TRAIT AVERAGES FROM OBSERVERS)

TRAITS		JEAN	GARLAND	HARRIETT	PHIL	FREIDA
CURIOSITY	A	2.25	2.83	2.00	1.20	2.00
	B	3.14*	2.86*	3.43*	3.29*	3.56*
CREATIVE IMAGINATION	A	2.25	1.83	1.25	.60	1.25
	B	1.57	1.14	2.14*	1.57*	2.14*
MANUAL DEXTERITY	A	1.63	1.83	1.00	2.00	1.63
	B	1.43	1.71	1.71*	2.29*	2.14*
PLANNING ABILITY	A	1.63	2.00	1.00	1.00	1.50
	B	3.14*	2.26*	2.29*	2.57*	3.71*
PERSISTENCE	A	1.37	.67	1.25	.20	.89
	B	2.71*	2.23*	2.71*	2.71*	2.71*
ABILITY TO SPOT A PROBLEM AND DETECT INCONSISTENCIES	A	1.63	1.33	1.13	.60	1.00
	B	2.23*	2.57*	2.00*	2.29*	2.57*

* Notes improvement in trait.

A = September, 1956
B = May, 1957

Summary and Recommendations

There are many methods for teaching elementary science. The use of the situation test as a method in problem solving in science is one of them. The value of this method is proved by the growth exhibited by the Experimental Class used for this study.

Growth was made in science knowledge, shown by the result of the Elementary Science Test, Form A. This growth was significant, shown by the result of the t-test. The test proved that the science facts learned by the Experimental Class were not accidental but due to the teaching methods used. The Experimental Class made an average gain of 4.41 points over the Control Class.

The Experimental Class grew more in social relations than the Control Class. The Russell Sage Social Relation Test showed the growth made in both planning and operating by the Experimental Class to be greater than that made by the Control Class.

Essential science traits were marked by degrees of improvement, shown by the observer rating for the Experimental Team in: curiosity, creative imagination, manual dexterity, planning ability, persistence, and the ability to spot a problem and detect inconsistencies. The observers showed much similarity of rating for each individual in each trait.

The Experimental Class grew in emotional stability and poise. This method developed qualities of leadership in many children and allowed each child a chance to find a place for himself that offered him approval and a feeling of belonging. The capabilities of the gifted children were stimulated and used. This method is most effective for the highest use of the talents of gifted children.

The situation test requires careful teacher planning. Collect the correct number and amount of material needed. Solve the problem before allowing the team and class to try. Be thoroughly familiar with it. Be prepared to handle original ideas from the team and class. Keep a time limit for planning done by team and class to a reasonable amount. Stop the team when the limit of its resources has been used.

The situation test requires careful teacher-class planning. Allow enough space for the activities desired. Arrange a balance in the type of activity in one class session--much movement and little movement. Plan a place for everyone.

The situation test requires careful evaluation of the work done by the team and class. This evaluation should be made on the criteria set by group planning.

The situation test has proven so successful in this study that it is the hope of the author that further studies will be made. The use of three or four experimental classes and an equal number of controls with similar results would enhance the value of this study and further verify the conclusions now reached.

This method of teaching offers possibilities for successful use in the field of social studies as well as science. It gives evidence of being successful for use in both Junior and Senior High School. The author would like to see this method explored in related areas and in different age levels above the sixth grade.

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Henry, Nelson B. (ed.) The Forty-Sixth Yearbook of the National Society for the Study of Education, Part I, Science Education in American Schools. Chicago: The University of Chicago Press, 1947.
This report discusses what the committee feels to be desirable objectives of science instruction. Section II deals with elementary school science instruction.

Kearney, Nolan C. Elementary School Objectives. Russell Sage Foundation. New York: Wm. F. Fell Company, 1953.
This is a report prepared for the Mid-Century Committee on Outcomes in elementary education.

Lane, Howard A., and Mary Beauchamp. Human Relations in Teaching. New York: Prentice-Hall, Inc., 1955.
This book uses illustrations from classrooms throughout the country to examine the quality and character of child life today.

Moore, Ruth. The Earth We Live On: The Story of Geological Discovery. New York: Time, Inc., 1956.
This book may be considered an effort to explain recent developments in pure and applied science to the general reader. It also develops the story of man's quest for knowledge about the earth, his home.

National Association Department of Elementary School Principals, 32nd Yearbook, Science for Today's Children, National Elementary Association. Washington, D. C.

These 311 pages offer ideas, helps, and suggestions from elementary school principals, science educators, and classroom teachers on science.

Northway, Mary L. A Primer of Sociometry. Canada: University of Toronto Press, 1952. Pp. 1-11.

This book discusses how to measure the social acceptance of each child within the class, by measuring the acceptability of each child by the class.

Oakes, M. E. Children's Explanations of Natural Phenomena. Contributions to Education, No. 926. New York: Teacher's College, Columbia University, 1948.

The purpose of this study was to determine the methods and types of explanations used by a group of kindergarten and elementary school children and by a non-scientific group of adults when they account for natural phenomena.

Osborn, Alex F. Applied Imagination. New York: Charles Scribner's Sons, 1953.

This book maintains that the student can be trained to use more productively the talent which he innately possesses.

Schneider, Herman, and Nina Schneider. Teacher's Guide for Today and Tomorrow. Boston: D. C. Heath and Company, 1956.

This is a manual to guide teachers in using Science In Our World.

Southern Association of Colleges and Secondary Schools, Promising Practices in Elementary Schools. Atlanta, Georgia: 1952.

Using a series of pictures with captions followed by a short commentary, the author offers promising practices in elementary schools.

Whitney, Frederick L. The Elements of Research. New York: Prentice-Hall, Inc., 1950.

Research methods and techniques are discussed in this book.

Wiles, Kimball. Teaching for Better Schools. New York: Prentice-Hall, Inc., 1952.

This book presents hypotheses for efficient learning which the author has developed from years of study and experience.

2. Books about Special Activities

Blough, Glenn O., and Marjorie H. Campbell. Making and Using Classroom Science Materials in the Elementary School. New York: Dryden Press, 1954.

This book might be considered a practical guide in making and using easily obtainable things for elementary science.

The Elementary Teachers Guide to Free Curriculum Materials. Published by Educators Progress Service.

This gives an annotated schedule of selected free maps, bulletins, pamphlets, charts, and books. A sampling is:

a. Electricity Around Us. 16 pp., cartoon-styled. General Electric Co.
b. The Magic of Communication. 40 pp., illustrated, about the telephone. Bell Telephone Company.

Greenlee, Julian. Teaching Science to Children. Dubuque: William C. Brown Co., 1955.

This is a book about elementary school science that is treated from the standpoint of child growth and development.

National Science Teachers Association. Science Teaching Today. Washington: A Department of NEA, 1951. Vol. I through VII.

These small volumes contain simple experiments for teacher and pupil to use in the upper elementary and junior high schools.

Otto, Henry J. (ed.) Curriculum Enrichment for Gifted Elementary School Children in Regular Classes. University of Texas Workshop Group, Austin Public Schools. Austin, Texas: 1954, pp. 41-74.

The suggested enrichment of activities for gifted children and the techniques for implementing them is presented in this chapter.

Parker, Bertha M. Science Experiences, Elementary School. Evanston, Illinois: Row Peterson, 1952.

This book offers what might be considered suitable science activities for elementary school use.

Source Book of Science Experiences for Elementary School Children. Division of Curriculum, (Intermediate Grades), Louisville Public Schools. Louisville, Kentucky: September, 1954. Vol. Two, Parts I, II, and III.

This source book attempts to: meet teacher needs; utilize child interest; develop basic understandings; suggest activities and experiments for the entire class and for small groups and individuals; present audio-visual aids; offer free inexpensive materials; suggest bibliography for teachers and children; and suggestions for evaluation.

3. Children's Science Books

Fenton, Carroll Lane. Prehistoric World. New York: John Day, 1954.
This book includes stories of animal life in past ages. It includes shells, dinosaurs, ice-age elephants and other examples of animal life.

______, and Mildred Adams Fenton. Our Changing Weather. New York: Doubleday, 1954.
This book is well-illustrated explanations of such things as rain, fog, wind, thunderstorms, cyclones and tornadoes.

Friskey, Margaret. The True Book of Birds We Know. Chicago: Childrens' Press, 1954.
Elementary information about different types of birds is offered.

Mallison, George Greisen and Lois Marion Mallison. A Bibliography of Reference Books for Elementary School Science. Washington: NSTA.

Parker, Bertha M. Golden Book of Science. New York: Simon and Schuster, Inc., 1956.
This is a captivating and enlightening encyclopedia of elementary scientific knowledge, with more than 450 pictures in full color. Basic principles are presented and at the same time children are introduced to the scientific methods of accurate observation and logical deduction.

Schneider, Herman, and Nina Schneider. Everyday Machines and How They Work. New York: William R. Scott, 1953.
Informal and fascinating revelations about the workings of such common and useful items as fountain pens, vacuum cleaners, refrigerators, faucets, pressure cookers, coffee percolators, valves, switches, electric lights and motors, zippers, scales, locks, musical instruments and a houseful of other things are given in this book.

______. How Your Body Works. New York: William R. Scott, 1953.
How do your eyes see, your ears hear, your feet go? How do you think? What makes your body healthy and how can you keep it that way? Easy, fun-filled experiments help to provide the answers to these and other questions about the wonder that is the human body.

______. More Power To You. New York: William R. Scott, 1953.
A short history of power from the windmill to the atom is shown.

________. Rocks, Rivers and the Changing Earth: A First Book about Geology. New York: William R. Scott, 1952.

This is the absorbing story of how, from the sparkle of a stone, the curve of a river or the slope of a hill, you can learn of giant forces at work millions of years ago. Soil, minerals, glaciers, oases, mountains, volcanoes—the very planet that we inhabit—take on new meaning for the young scientist.

Shippen, Katherine B. Mr. Bell Invents the Telephone. New York: Random House, 1952.

Details of the invention of the telephone from the nights of experimentation with tuning forks in his bedroom to the completion of the transcontinental telephone in 1915 are given.

Tannehill, Ivan Ray. All About the Weather. New York: Random House, 1954.

This book tells how to observe the weather, how to forecast it, and how to read weather maps.

Wyler, Rose. The First Book of Science Experiments. New York: Franklin Watts, 1952.

Simple experiments with air, water, plants, electricity, chemistry and light that may be done with home equipment are given.

B. PERIODICALS

1. Adult

Craig, Gerald S. "Elementary School Science in the Past Century," The Science Teacher, Vol. 46 (February, 1957) pp. 11-14+.
This article tells of the advances made in elementary science teaching and of some problems that relegated it to a casual place for many years.

______. "Science in the Elementary Schools," What Research Says to the Teacher, Vol. 12, Department of Classroom Teachers, American Educational Research Association of the National Education Association.
This pamphlet is an effort to get into the hands of the classroom teacher the continually advancing field of educational research.

Harap, Henry. "Today's Elementary School," NEA Journal, Vol. 46 (February, 1957) pp. 78-80.
A resume of practices used in elementary schools visited by this author and recounted.

Read, John R. "A Non-Verbal Test of the Ability to Use the Scientific Method as a Pattern for Thinking," Science Education, Vol. 33, pp. 361-6.
This paper describes a test which may be used for measuring the possession of scientific method of thinking talent.

Schneider, Herman. "What Can Science Do?" Science Notes from Curriculum Service, Vol. 13, No. 1. New York: Scott, Foresman and Company, Winter, 1954, pp. 1-3.
This article discusses why elementary science teaching is so necessary to effective living today.

Shane, Harold G. "Children's Interests," NEA Journal, Vol. 46 (April, 1957) pp. 237-239.
Utilization of child interest is discussed by this author.

Swann, Bryan F. "Science Provisions for the Rapid Learner," The Science Teacher, Vol. 42 (September, 1953) pp. 182-186.

Thurber, Walter A. Elementary Science and Mental Health. New York: Allyn and Bacon, Inc., 1956.
This booklet discusses possible ways elementary science can aid mental health, and demonstrates how beneficial changes come in children themselves.

2. Children's

Shackelford, Frederick H. (ed.) Earth and Sky: The Science Magazine for Boys and Girls. Pasadena, California: Outdoor Publishing Company, 1945.

This magazine is published on the first and fifteenth of each month from September 15 to June 1. It contains pictures, stories, puzzles, experiments, poems, and true-false statements based on the stories. It attempts to cover the elementary science field.

Scientific American. Scientific American, Inc., New York.

Each year the December issue of this magazine gives reviews of what appear to be the significant science books for children that have been published during the year.

C. UNPUBLISHED MATERIAL

Division of Instruction, Richmond Public Schools, Elementary Teachers' Science Bulletin, November, 1956.

Division of Instruction, Richmond Public Schools, Elementary Science Bulletin, Spring, 1957.

Boger, Dr. Jack.(ed.) Tests and Measurements, Department of Instruction, Research Division, Richmond Public Schools, 1951.

VITA

Hilda Scott Harwood was born on January 26, 1911, in Richmond, Virginia. She is the daughter of Margaret Elizabeth Shepherd and William James Scott. Her school life began at four and a half years of age, when she entered Grace Arents School in September of 1915. The next year her family moved to the north side of Richmond, where her elementary schooling was completed by attending George Thorpe and J. E. B. Stuart Elementary Schools.

Secondary schooling included study at Binford Junior High School and John Marshall High School.

In February of 1928, she entered Richmond Normal School. Having received a Normal Professional Certificate, she was employed as a fourth grade teacher in the George Thorpe Elementary School.

In June, 1934, she married William Morris Harwood.

Desiring a Collegiate Professional certificate, she attended summer school at William and Mary College and Duke University. She also attended night school at Richmond Professional Institute. The schooling was completed at the University of Richmond Summer School in August, 1947, when she received a Bachelor of Arts degree with a concentration in Education.

Transferring to the J. E. B. Stuart Elementary School in September, 1947, she taught the sixth grade there for ten years. In September of 1957, she will be challenged by a new job, General Consultant for the Elementary Grades in Richmond, Virginia.

Her educational experiences continue with graduate work in the Summer School at the University of Richmond (1952-1957), leading to the degree of Master of Science in Education.