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THE EFFECT OF THE HOLISTIC APPROACH OF TEACHING
ELEMENTARY SCIENCE EDUCATION IN REALIZING THE
PROCESS OF DISTINGUISHING AND MANIPULATING
CONCEPTS OF MAGNETISM WITH CULTURALLY
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Westbrook Arthur Walker

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ABSTRACT

THE EFFECT OF THE HOLISTIC APPROACH OF TEACHING ELEMENTARY SCIENCE EDUCATION IN REALIZING THE PROCESS OF DISTINGUISHING AND MANIPULATING CONCEPTS OF MAGNETISM WITH CULTURALLY DIFFERENT CHILDREN

By

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Purpose

The purpose of this study was to determine whether fifth and sixth grade culturally different learners who had been taught by instructional television, motion pictures and audio tapes would be better able to perform distinguishing and manipulative tasks better after an instructional sequence had been presented to them than before the presentation of the instructional sequence.

This study provided the basis for testing the effectiveness of an instructional strategy called the Holistic Approach in the teaching of elementary science. It permitted the opportunity to establish the value of a non-verbal evaluation instrument in adequately assessing the cognitive achievement of culturally different children.

Design and Analysis Technique

This study used a quasi-experimental longitudinal and time series design. The data collected in the study was

interpreted by use of acceptable statistical techniques for assessing the achievement of participants exposed to the teaching technique applied during the study using a one group pre and post-test design on the experimental group.

The statistical tests used were (1) the Analysis of Variance, (2) Analysis of a Multivariate Linear Model and (3) the Univariate and Multivariate Analysis of Variance, Covariance and Regression for Trend Analysis.

Populations

Sixty-seven elementary children from one school were used in a large group setting in an inner city area in the Buena Vista Township located in Saginaw, Michigan. The sample consisted of twenty-one fifth graders and forty-six sixth grade youngsters. The cultural identification of the sample consisted of six Mexican Americans, one White-American and sixty Black-Americans.

Instrument

The evaluation instrument used featured fifteen 8 x 10 high-glossed magnetic photograms produced by a photographic chemical process. The lines of forces captured on the magnetic photograms were produced by manipulating magnets beneath photographic paper sandwiched between two clear sheets of plexiglass. Iron filings were sprinkled on the plexiglass producing the lines of forces to be reproduced by the learner. Written questions were developed for the study to accompany a pictorial

diagram of randomly arranged particles. Symmetrically arranged particle drawings were also designed to explain magnetized and non-magnetized substances.

Findings in the Study

The major findings of the study were:

1. The strategies used for the Holistic Approach differed in techniques and philosophies from the conventional utilization of strategies. The varieties of strategies employed in this study offered the participants procedural options of selecting and utilizing a specific strategy designed for differing learning styles. Moreover, it was found that the participants were able to execute tasks better after the instructional sequence had been applied than before. The application of the instructional sequence supported the conclusion that the cognitive abilities of culturally different children were enhanced and improved when direct, specific verbal instructions were given in the language of their environment.
2. The use of action verbs to articulate a specific objective proved effective in increasing the participants' ability to achieve. The objective of using action verbs was accomplished and proved effective, suggesting that the participants of the study did not have to "figure out" what was expected of them.
3. Correlational techniques supported the assumption that the participants of the study were able to conceptualize and solve problems.

4. It was found that neither the reading level categories nor the language usage categories of the participants hindered their abilities to achieve equally on the post test.

5. The use of the non-verbal instrument designed for evaluation was effective for assessing achievement of culturally different children in this study.

6. The usage of an behavioral-objectives teaching pattern featuring expected outcomes, predictive academic performances and the variety of instructional strategies played a major role in the achievement of the participants in this study.

7. The results of this study showed a significant linear trend with a resulting conclusion of equal achievement for all participants as measured by post test scores.

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By

Westbrook Arthur Walker

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WALKER

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1973

DEDICATION

This Dissertation is dedicated to the following persons:

Molly McCray - Aunt
Ella Walker - Grandmother
Frank and Helena Walker - Father and Mother
Willie Glove Love - Aunt
Viola G. Evans - Aunt
Joe F. Walker - Brother
Earnestine Pace and Family - Sister

My Children:

Angela Marie
Westbrook A. II
Marcellus André
Earnestine Denise
Andrea Olympia
Demetrius Ellis
Tameka Lynn
Sean Tremane - Grandson

My Wife:

Marion Lee

If a man does not keep pace with his companions,
perhaps it is because he hears a different drummer.
Let him step to the music which he hears,
however measured or far away.

--Henry David Thoreau

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CHAPTER I

THE PROBLEM

Introduction

Science is taught in elementary schools to bring about pupil growth in the cognitive, affective, and psychomotor domains of knowledge.

In most classrooms a major part of the school day is spent with language arts and mathematics. In too many instances these subjects are taught as mechanical skills with little deviations in approach from day to day. In many classrooms, science has become another skill to master Although children are often not highly motivated by this type of science instruction, many teachers continue their strategy and in many instances watch their children's interest in science slowly deteriorate.¹

The teaching of science has been historically directed toward the production of scientists with little consideration being given to those children who are only interested in the consumerable use of science. Curricula for elementary science have been responsible for creating tasks for accomplishments in a content style without any primary intent of the content, except to promote the memorization of facts about phenomena found within the physical universe.

¹Paul C. Beisenhertz, "Effecting Change in Elementary School Science," Science and Children, X, No. 3 (November, 1972).

Curricula of elementary science should be more specifically purposed. For elementary science learners, who are required to master content materials, there should be objectives states in specific behavioral terms. To accompany the specified objectives, a variety of teaching strategies should be provided. These varied learning strategies would provide the opportunity for learners manifesting different learning styles, to elect a strategy comparable to his or her learning style. To effectively facilitate favorable conditions for learning of the content material, appropriate media should be available for use to completely execute each part of all available teaching strategies provided for learning.

The review of the literature for this study supports the fact that many changes have been brought about in the history of American elementary curricula. However, none of the newly adopted curricula have existed for any length of time.

Literature research showed that most changes were brought about as a result of philosophies without assessable, meaningful objectives or technology. The habits elementary learners found within these curricula changes often showed signs of restraint imposed by overindoctrinated adults who often attempted to tame the delightful originality of the learner.²

²John Dewey, Human Nature and Conduct (New York: Henry Holt and Company, 1922).

Traditionally, the values and ideals which have been conceptualized in the elementary school curricula reflect the attitudes of society which support the schools. When changes in societal need develop, the curricula in elementary science, for example, must move to implement the need through new methodology and programs of a positive nature.³

Schools have often projected the idea in science education that the strategies of science are the only way to seek truth. Elementary science education can play a significant role in providing the opportunity for learners to realize that although science is a way of knowing, it is not the only way. Elementary science curricula must focus upon all of the facets of growth potential of the learner, permitting the development of a wholesome, psychologically sound educated individual.

Need for the Study

The environment in which learners are placed plays an important role in the amount of measurable learning that does occur. Persons responsible for this environment can realize maximum growth from the learners by providing the proper atmosphere and by facilitating the necessary structure and equipment for that growth. The role of the facilitators can help learners use knowledge gained in

³Roger W. Bybee and I. David Welch, "The Third Force: Humanistic Psychology and Science Education," The Science Teacher, XXXIX, No. 8 (November, 1972).

their experiences rather than merely having the learner compile facts of science. The role of the facilitator can also provide the desire for elementary science learners to search for basic principles and generalize from these basic principles.⁴ However, facilitators responsible for a learning environment should consider the following four conditions:

- (a) selecting, organizing the content and stating the objectives of instruction as observable participant behavior;
- (b) making and implementing instructional decision;
- (c) creating devices for measuring participants achievement, and
- (d) evaluating the appropriateness of objectives, the effectiveness of instruction and the validity of measurement techniques.⁵

An instructional design must also show a sequence of three basic requirements for use as a possible model. These requirements are input, process and output.⁶ Each component specifies a specific and different function.

Input includes students' entering ability and situation constraints; process transforms input abilities into output behavior and, output states specific student performance capabilities.⁷

⁴David P. Butts, "The Relationship of Problems Solving Ability and Science Knowledge," Science Education (March, 1965).

⁵John B. Hough, "Ideas for the Development of Programs Relating to Interaction Analysis," Innovative Ideas In Search of Schools: Title III, PACE (Lansing: State Board of Education, 1966), p. 97.

⁶C. Victor Bunderson and David Butts, "Designing an Instructional Program--A Model; Designs for Progress in Science Education" (National Science Teachers Association, Inc.), p. 59.

⁷Ibid.

The following figure represents a designed instructional package with standards of documentation that have often escaped most published material. Figure 1 shows a prescriptive approach to the design of an instructional system.

Reading levels and language usage often caused misinterpretation of written tests by learners of different cultural backgrounds, when the tests are used to show achievement in the cognitive domain. However, there is less frequent use of alternative testing techniques for assessing the cognitive growth of these learners having different background and cultural orientation.

The use of non-verbal material for instruction, has proved successful in areas of the deaf, blind, and for learners having other auditory and speech difficulties. It appears that use of non-verbal communication for culturally different groups having difficulty with "standard" reading techniques, and language usage requirement would benefit greatly by use of an instructional sequence using a non-verbal instrument for assessing the amount of cognitive growth occurring over a period of time.

In the last several years, Buena Vista School District has achieved in the lower ranks of academic performance on the assessment test required by the State of Michigan. Thus an attempt to test the academic abilities of the learners of the study area by a method other than by use of a written

Design ActivitiesDesign Products (for Program Manual)

1. Needs and Justification

- a. Write societal need.
- b. Write program goals.
Describe "job"
requirements.
- c. Write justification
of approach

Describe the social context
requiring an educational program.

The situation in which graduates
will find themselves, and the
things they will need to do.

Why are the media and general
approaches appropriate to the
program goals (in contrast to other
ways)?

2. Instructional Design

- a. Goal synthesis. Derive
particular terminal
objectives.

Behavioral objectives.

Set entering per-
formance standards

Prerequisites.

Effect of constraints
on program design.

Narrow choice of media and
methods.

- b. Analysis of task and
learner.

Derive intermediate
objectives.

What must learner be able to do to
achieve higher-order objectives?

Construct learning
hierarchy.

What is the prerequisite relation-
ship among objectives?

Specify relevant learner
attributes.

Which traits or background knowledge
differences interact with possible
instructional methods?

3. Evaluation and Revision

- a. Editorial evaluation.
- b. Internal empirical
evaluation
- c. External empirical
evaluation

The product is changed in the program.

Do learners meet terminal
objectives?

Item analyses and revision

Longitudinal validation--
do graduates meet
"job" requirements?

Revision data if appropriate.

- 4. Use of Feedback: Return to
any previous step as
indicated by evaluation;
revise and recycle.

Revision data if appropriate.⁸

Figure 1.--A prescriptive approach to the design of instructional systems.

⁸ Ibid., p. 60.

test could prove significant to the investigator in determining whether there is cultural bias in the test or whether the deficiency is due to the internal structure of the school district.

Purpose of the Study

The purpose of the study is to determine whether fifth and sixth grade learners taught by instructional television and other media, will be able to better distinguish and perform manipulative tasks which will be determined by use of a non-verbal instrument developed for the holistic approach.

The instructional sequence was designed, developed and written specifically to teach fifth and sixth grade learners to distinguish between different magnetic lines of forces and to manipulate magnets producing specified magnetic field patterns.

This study would allow for the development of a physical representation which could provide a basis for the explanation of phenomena they cannot see, thus producing a condition of scientific explanatory.

Individual classroom teachers often admit that they are poorly equipped to teach underlying concepts of magnetism. Learners at the fifth and sixth grade levels, on the other hand, are keenly interested in this area and receive limited satisfaction through traditional instruction. The learner is often given facts but is seldom

allowed to investigate for suitable explanations of what actually happens in this area of study.

While the primary purpose of this study is to develop a schema for the Holistic approach and an appropriate instructional sequence to the teaching of science, it also provides the opportunity to develop a new image for instructional television within the project community. Too frequently parents and teachers have become disenchanted with ITV because they have been exposed to poorly produced programs.⁹

Operational Definitions

1. Cassettes: For this study cassette will be taken to mean an enclosed case which contains two little hooks that permit reel to reel recording and playback.

2. Audio tapes: For this study audio tape will be taken to mean electromagnetic tapes produced for cassette tape players to be used for instruction.

3. Holistic approach: For this study, holistic will be taken to mean that process which involves the use of multi-media materials, multi-media techniques, three-dimensional objects, pretest, post-test, laboratory investigation, and humanistic psychology.

⁹ Donald G. Wylie and Robin Halley, Needed: A New Image for ITV: Audiovisual Instruction (May, 1971).

4. Humanistic: For this study, humanistic will be taken to mean that overtly observable human characteristic which manifests sincerity, love, concerns, sensitivity and care for participants.

5. Instructional television (ITV): For this study ITV will be taken to mean that type closed circuit television system which limits distribution of an image and sound directly connected to the origination point by coaxial or microwave link and is used for instructional purposes only.¹⁰

6. Lines of force: For this study, lines of force will be taken to mean curving lines moving from one end of a magnet to another, all of which produce the magnetic force field.

7. Magnetic force field: For this study, magnetic force field will be taken to mean that field produced by magnets, which offers a push or pull by the magnet.

8. Magnetic fields: For this study, magnetic fields will be taken to mean the force field that surrounds the magnet, caused by electrons moving in orbital paths establishing a condition called orbital motion and electron spins. These influences are measureable or mechanically represented.

¹⁰Vernon S. Gerlach and Donald P. Ely, Teaching and Media (Englewood Cliffs, N.J.: Prentice Hall Inc.), p. 386.

9. Magnetic materials: For this study magnetic materials will be taken to mean those materials that are visually affected by magnets by showing an attraction to a magnet or by showing repulsion from a magnet.

10. Magnetic photograms: For this study, magnetic photograms will be taken to mean a high gloss black and white photographic print produced by a photographic developing process. This print is used as an instrument for evaluation.

11. Motion pictures: For this study, motion pictures will be taken to mean a recording of a moving image in color or black and white produced from live action or from graphic representations. Objects or events may be in normal motion, in slow motion, time-lapse, or stop motion.

12. Participants: For this study participants will be taken to mean those sixty-seven elementary fifth and sixth graders subjected to treatment and to evaluation in the study.

13. Video tape: For this study video tape will be taken to mean an electromagnetic tape produced to be used with a video tape recorder.

14. Video tape recorder (VTR): For this study VTR will be taken to mean an electronic device which permits the recording and playback of video images and sound production.

All operational or stipulative definitions have been defined using the guidelines for educational research established by Sax who proports:

. . . A stipulative or operational definition allows the researcher to define any term in any way he sees fit as long as its meaning is clear to the reader. . . . Stipulative or operational definitions can be neither true or false.¹¹

Some of the terms included have been given lexical or informative definitions to facilitate the ease of thesis preparation.

Research Hypotheses and Hypotheses Tested

Fifth and sixth grade students who receive instruction utilizing the holistic approach to the teaching of magnetic materials and magnetic fields, using Instructional Television as a teaching device, will score higher on a post-test within a five week period than on a pretest given at the inception of the unit on magnetism using the same instrument for repeated measures during the study.

The hypotheses tested for this study were listed in the following null form:

Ho₁: There will be no mean improvement between the pre- and post-test in the participants ability to perform distinguishing and manipulation tasks as measured by the instrument constructed for the "Holistic Approach."

¹¹Gilbert Sax, Empirical Foundations of Educational Research (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968), p. 117.

- Ho₂: There will be no mean improvement in achievement per class, between the pre- and post-test, and will not represent 80 per cent of the content material being successfully mastered by 80 per cent of the participants, as evidenced by the instrument constructed for the "Holistic Approach."
- Ho₃: There is no correlation between the final scores on reading skills, and the final scores on concept skills as determined by the Iowa Test of Basic Skills.
- Ho₄: There is no correlation between the final scores on reading skills, and the final scores of problem solving skills determined by the Iowa Tests of Basic Skills.
- Ho₅: There is no correlation between the final scores on language skills and concept skills as determined by the Iowa Test of Basic Skills.
- Ho₆: There is no correlation between the final scores on language skills and problem solving skills as determined by the Iowa Test of Basic Skills.
- Ho₇: There is no difference between the ability of the three reading levels groups to achieve equally as well on a post-test measure as determined by the post-test scores on the experimental study.
- Ho₈: There is no difference between the ability of the groups of language usage levels to achieve equally as well as measured by the post-test scores on the experimental study.
- Ho₉: There will be no difference in improvement of the three classes on each measurement M₁----M₇ on the experimental study.
- Ho₁₀: There will be no interaction between classes and reading levels on the post-test scores of the experimental study.
- Ho₁₁: There will be no interaction between classes and language usage levels on the post-test scores of the experimental study.

Overview of the Procedures and Analysis

This study used a quasi-experimental longitudinal or time series design. The data collected in the study was interpreted by use of the following statistical techniques for assessing the achievement of participants exposed to a teaching technique applied during a study, using a one group pre- and post-test design on the experimental group. Below are the statistical tests:

1. Analysis of variance.
2. Multi-variate analysis.
3. Trend analysis.

This study focused on the fifth and sixth grade levels with a particular instructional sequence and specified materials written and developed by the investigator.

Sixty-seven elementary school children from one school were used in a large group setting in an inner city area in the Buena Vista Township located in Saginaw, Michigan.

The cooperating teachers of the participants used were given in-service training involving the philosophy and utilization of the prepared materials to be used in the study. They were also taught to use the data-collecting device effectively and to interpret the conditional lines

of force behaviors as found on the fifteen magnetic photographs used for testing the distinguishing and manipulative ability of each participant. The teachers became acquainted with the objectives of the study. They also studied the objectives of the work book which had been written in terms of simple human behavioral performance. There were five observations made aside from the pre-test and post-test.

Basic Assumptions.--

1. This study begins with the assumption that any significant gain in achievement between the pre-test and post-test scores of this experiment will be attributed primarily to the application of the Holistic Approach.

2. That the reading level of learners makes no difference in the ability of learners to perform tasks that are orally stated and graphically illustrated.

3. That language usage of learners does not hinder the ability to perform tasks when stated in language or terminology that is understandable by the learners.

4. That repeated measurement over time will show a significant growth in performance if the learners know exactly what is expected of them.

5. That instructional material presented in parts of a total sequence will enhance the desired outcome of the study.

6. That the time limit of five weeks is sufficient to accomplish the 80/80 prediction of this study.

7. That experimental isolation, used as a vehicle, will provide the control necessary to preserve the history of this study during the five week period of this study.

8. That interest in subject matter content will escalate, when the facilitation allows for a variety of media and personal interaction of the participants of the study with the materials provided.

9. That selection of the curricula, media, and strategies used were adequate for the participants of this study.

10. That a non-verbal instrument is capable of effectively evaluating the progress of the participants of this study.

11. That cultural freedom will be evidenced by use of the non-verbal instrument and achievement will be significant.

Limitations of the Study.--

1. The population to which the conclusion of this study can be applied is the sample of fifth and sixth graders of the participative study area (Buena Vista #9 School District; Archer Claytor Elementary School).

2. Although the study has positive statistical use, its practical use can only be inferred to the investigated area.

3. The design of the study will be limited to areas having similar type equipment which can be used for the curricula and the study replications.

4. The scope of the supplementary activities and materials were limited by the investigator.

5. The study is limited to a time series or longitudinal study with repeated measures, without a control group.

6. The study was limited to academic achievement in science without consideration given to the measuring of attitudes of learners.

7. The study is limited to developing and measuring the distinguishing and manipulative skills of participants.

Overview of the Thesis

Chapter I has been developed to articulate existing conditions in the area of elementary science education. These conditions were developed through continuing efforts to up-grade the elementary science curricula, methodology and technology. The revealing of the aforementioned efforts provides the basis for describing the nature of the problem for this study. The introduction in Chapter I serves as a prelude to developing the Need for the Study. The inconsistencies found in the Need for the Study provides the necessary information for developing the Purpose of the Study.

The language needed to describe the study is provided by the operational and lexical definition of terms of the study. With the research hypothesis and hypotheses tested, basic assumptions and the limitation of the study provided, the remaining portion of the thesis is structured thusly.

Found in Chapter II, Review of the Literature, is an introduction, a historical legacy of the trends in elementary science curricula from the early eighteenth century to the Pestalozzian era in the United States continuing through the Nature Study Movement. Following the Nature Study Movement, the legacy continues to New Direction in Science Curricula based on the philosophy of James, Pierce, and others, to Dewey and Craig. Also included are comments from the Thirty-First, Forty-Sixth and Fifty-Ninth Yearbooks to Recent Trends in Elementary Science Curricula. Discussion continues from the National Science Foundation funded projects to governmental reaction and effects on existing science projects, to pedagogy and structure within a discipline.

Chapter III, the description of the study, deals with a narrative discussion of the design used and the procedures applied for selection of population for the study along with descriptions of subject matter content written and activities designed for the study. This chapter also points out the mechanistic application of instructional

sequences, expected outcomes, and a prediction of an acceptable performance as a standard for the development of an evaluation model to be used for assessing the achievement of the participants of the study.

Chapter IV includes the analytical treatment of the data collected and the findings in the study. This chapter attempts to corroborate the claims made by the investigator prior to the undertaking of the study.

Chapter V includes the summary, conclusions, implications and recommendations as a result of the study.

Chapter VI, the appendix, includes bibliography, copies of television scripts, workbooks, electromagnetic tapes script, excerpts and comments from ITV scripts, copies of typed cards, representative "Supers," copy of the instruments, data, the data collection vehicle and drawings of the magnetic photograms used in the study.

CHAPTER II

REVIEW OF THE LITERATURE

While "improved" curricula, innovations and philosophical transitions have generally been accepted by teachers as vehicles to increase interest and encourage digestion of subject matter by pupils, the recent upsurge in science curricula has not been a reliable "fingers in the wind" indicator as to the direction which science education is apt to take in the future. Past curricula changes in themselves have not been able to guarantee measurable outcomes in content, so there is growing support to consider alternate techniques which might successfully help realize individual pupil interest, thought and comprehension of science education goals and objectives.

The review of the literature for this study will attempt to show some of the results of contemporary curricula change as well as to identify alternative proposals for increasing pupil growth and realizing educational objectives. The historical accounts of the changes in the curricula of elementary science and the rationale for change have not justifiably included a workable technique and/or alternative sequence for the teaching of elementary science, but have highlighted the theories and philosophies

upon which curricula changes have been made. Too often, the predicted basis for change have waned.

The review of the literature for this study will be conducted on the following sequence:

1. historical trends in elementary science education curricula,
2. recent trends in elementary science education curricula,
3. pedagogy and/or systems as a technique for improving instruction in elementary science curricula.

Being a curriculum worker these days is no easy task. As American education goes through the growing pains of revitalization and adaptation to new social goals, curriculum workers are confronted with a bewildering array of innovations, each with its champions and its critics, all loudly proclaiming their special points of view. In addition, providing school materials has become a more lucrative business and schools everywhere are finding themselves the target of the hard or soft sell by American industry as never before.

As a consequence, curriculum decision has been made much more difficult than ever and it is hard for a conscientious worker to know who and what to believe.¹

Historical Trends in Elementary Science Curricula

Historically elementary school science has been found in elementary school curricula designed to be used by and for the education of children as early as the

¹Arthur W. Combs, "Forewords," The Changing Curriculum Science, ed. by Richard E. Haney (Association for Supervision and Curriculum Development, NEA, 1966), p. v.

eighteenth century. According to historians, men and women were ignorant and untrained, the curricula very limited, the methods inefficient and time was wasted. Historians seldom mention the use of apparatus such as blackboards, pictures, globes and maps in the teaching process.² Underhill states that:

Comenius has frequently been referred to as the first to introduce the study of nature into the schools. The Orbis Pictus is the most famous of these early attempts at the study of 'things not works,' although not the first.³

Direct observation of natural occurrences did not, however, occur in literature for children until the late seventeenth hundreds and early eighteenth hundreds. The effects of this literature lead to the first practical application of educational theory which later extended great influence on the practices in schools. These writings and methods were much more improved over earlier eighteenth-century methods.⁴

These materials in the early writings classified as 'didactic literature,' specifically prepared for the education of children in form of literature began to shift from children's literature to instructional materials which were of the same content and was used by tutors of the children, which later

²Clifton Johnson, Old Time Schools and School Books (New York: MacMillan Co., 1909).

³Orra E. Underhill, The Origins and Development of Elementary School Science (Scott-Foresman and Co., 1941), p. 14.

⁴Ibid., p. 15.

influenced the use of these materials in the homes by parents as well.⁵

Early Writers of Elementary Science Curricula

Thomas Day wrote science materials for elementary curricula as evidenced by the appearance of some astronomy and biology in his writings of Sanford and Merton.⁶ Having an exceptional ability for digesting enormous amounts of material, he had at his disposal a tremendous wealth of information for publication and was noted to be a dedicated disciple of Rousseau. Aikens writes that Mrs. Anna Wetilia Barbould, wrote in collaboration with her brother, books in science and were used by both her husband and herself in a school conducted by them for young children.⁷ The curricula consisted of descriptive materials including such materials as the provision for food, clothing, and shelter. They also centered around topics that are commonly found in a contemporary social studies curricula. The curricula material also gave much cultural information for children. The influence of Mrs. Barbould reached far and some of it was inherited by Maria Edgeworth.

⁵Emalyn E. Gardner and Eloise Ramsey, A Handbook of Children's Literature (Chicago: Scott, Foresman and Co., 1927), p. 175.

⁶Underhill, op. cit., p. 17.

⁷John Aikens, The Ants of Life (Boston: Samuel H. Parker, 1803).

Edgeworth's lessons were patterned after Mrs. Barbauld's Lessons for Children and were meant:⁸

. . . to entice young people to the study of mechanical contrivances and scientific apparatus, which are commonly classed under the head of useful inventions. The chief aim of this work, however, is to present all these subjects in that light in which is best suited to produce careful comparison, to elicit judgment and reflection, and to suggest such combinations of thoughts as may aid in inventive effort of the imaginative faculty.⁹

Hare writes that Edgeworth had personally met such scientists as Boyle, Davey, Erasmus, Darwin, Madam Rumford and concludes that this first hand exposure to the works of these scientists, gave her "first hand" exposure to the processes and attitudes used and exhibited by them.¹⁰

Murch in his works points out that some of the best type serious books were written by Abbott, an American mathematics professor.¹¹ He wrote sixty-eight volumes with several volumes devoted to science Abbott patterned his work after that of Barbauld and others. His books were designed to relate to the effect upon the children's habits of thinking, reasoning and observation, and its content covered material such as optical illusion, diffraction of light, clouds, rainbows, dew on stems, etc.¹²

⁸Maria Edgeworth, Harry and Lucy (Boston, 1825).

⁹American Journal Education, Vol. 1 (1826), p. 191.

¹⁰J. C. Augustus Hare, Maria Edgeworth's, Life and Letters (New York: Houghton Mifflin Co., 1895).

¹¹Jerome Murch, Mrs. Barbauld and Her Contemporaries (London: Longman, Green, 1877), pp. 30-31.

¹²Ibid.

The religious puritanical influence in elementary science curricula began to dwindle after one hundred and fifty years, and instructional material becomes more prevalent in the schools in forms other than folktales and fairy tales.¹³

The books in the latter part of the eighteenth century showed definite signs of instructional improvements. Fields says:

About this time there began to appear the earliest of those little books which endeavored to give information on all manner of subjects, history, astronomy, science, natural history, botany, manufacturers.¹⁴

Brief Summary.--

1. Group instruction was the primitive focus of the early writers in curricula and stressed the study of things and occurrences.
2. The techniques used for the group discussions were:
 - a. description of objects and pictures of objects,
 - b. reading about science--no investigation.
3. Elementary science curricula was predicted on theology although most of its writings involved phenomena.

¹³Ibid., p. 32.

¹⁴E. M. Fields, The Child and His Book (London: Wells Gardner, Darton and Co., 1891), p. 256.

Doctrine of Pestalozzi: Effects of
Pestalozzianism on United States

Reisner says that the Pestalozzian method of teaching was the most exciting curricula for elementary-school methods during the eighteen hundreds, and classes the method as one of the most reform movements which sprang up as a result of expression of current dissatisfaction.¹⁵

Pestalozzi says:

A man who has only word wisdoms is less susceptible to truth than a savage. The use of mere words produces men who believe they have reached the goal, because their whole life has been spent in talking about it, but who never ran toward it, because no motive impelled them to make the effort. . . . I come to the conviction that the fundamental error . . . the blind use of words in matters of instruction . . . must be exterminated before it is possible to resuscitate life and truth.¹⁶

While Pestalozzi's work was well established in Europe before coming to America, he believed that:

The highest attainment can only be reached by means of a finished art of teaching, and the most perfect psychology; thus securing the utmost perfection in the mechanism of natural progression from confused impressions to intelligent ideas.¹⁷

After Pestalozzi had analyzed the school system of his day and found them very much lacking, he began to establish a methodology and psychology to improve learning

¹⁵Edward H. Reisner, Evolution of the Common School (New York: MacMillan, 1930), Chapter XXI.

¹⁶Herman N. Krusi, Pestalozzi: His Life, Work, and Influence (Cincinnati: Van Antwerp, Bragg and Co., 1875), p. 152.

¹⁷Ibid., p. 154.

conditions. He justified his efforts using the following philosophy:

Whatever, therefore, man may attempt to do by his tuition, he can do no more than assist in the effort which the child makes for his own development. . . . The knowledge to which the child is to be lead by instruction, must therefore, necessarily be subjected to a certain order of succession, the beginning of which must be adapted to his first unfolding of his powers, and the progress kept exactly parallel to that of his development.¹⁸

The following three ways are indicative of the Pestalozzi method presented to children who become of school age.

1. To give names of letters, figures, and other symbols, followed by definitions, rules, and/or limited number of facts, most of which have no relation to those already known to the child. . . .
2. To allow children to continue for a time in school the plays which they have learned at home, thus giving vent to their natural activity. . . .
3. To place objects before them in which they are interested, and which tend to cultivate their perceptive faculties; and, at the same time, lead them to name the object, to describe its parts and state the relation to its parts.¹⁹

The third of these methods leads to the famous object teaching.

Object Teaching.--Pestalozzi's theoretical work based on emphasizing description of animate and inanimate objects, was virtually the basis of all the early elementary

¹⁸Ibid., p. 155.

¹⁹Ibid., p. 162.

science that was taught in the United States and was categorized as "object teaching."²⁰

Many educators of America introduced some of the best phases of object teaching into texts, lesson plans and much of their educational practices.²¹ Near the end of the nineteenth century, a shift in emphasis occurred with the need for a common program for pupils resulting from assorted displeasure with object teaching.

Dickens describes his concern for object teaching by saying:

. . . perhaps the three quarters of an hour spent was too long a time for acquiring a few facts about a penny. . . .²²

A description of the methodology used in object teaching is described by Calkins, he says:

pupils should be lead to point out and name the parts of common objects, to tell the shape of the parts, and the uses, color, etc., of the objects. This exercise should be conducted as to give the children the ability to describe readily objects which they see. . . .²³

²⁰Edward Victor and Marjorie Lerner, Reading in Science Education for the Elementary School--Herbert A. Smith, "Historical Background of Elementary Sciencet" (New York: The MacMillan Co., 1967), p. 34.

²¹H. B. Wilbur, "Object System of Instruction," American Journal of Education, Vol. 15 (March, 1865), pp. 190-208.

²²Charles Dickens, "Object Teaching," Massachusetts Teacher, Vol. 15 (July, 1862), pp. 258-261.

²³Thomas Kiddle, Thomas F. Harrison, and N. A. Calkin, How To Teach (New York: American Book Co., 1877), p. 59.

Clakins further encourages the utilization of objects by suggesting:

Objects having special qualities in a prominent degree should be shown, and the pupils led to observe a given quality in several objects, as a means of teaching them to recognize the same quality whenever it may come within their observation. . . .²⁴

Harrison feels that the importance of ordering as a method of teaching elementary science will allow for the transfer of knowledge gained or observations made from one object to another within a particular order, when he described the necessity of orders or families in saying:

Such of the orders or families, should be taught as one very familiar, and depend upon quite obvious distinctions, familiar names being exclusively used.²⁵

He continues by specifying:

. . . Thus the Mustard Family, the Pulse Family, the Crowfoot Family, the Rose Family, the Lily Family, etc., . . . may be taught as far as the collection and presentation of specimens render it desirable; that is, not the mere fact that there are such families, but in connection with an actual object, and when the inquiry is, to what family does it belong? . . .²⁶

However, good object teaching was, critical analysis began to creep into the literature. Bernard writes:

A common error committed in object teaching is in converting exercises that should be strictly for development, into instruction in abstract science. . . . To this end the senses must be exercised on

²⁴Ibid.

²⁵Thomas F. Harrison, A Book of Methods (Cincinnati: Electric Press, Van Antwerp, Bragg and Co., 1877), p. 167.

²⁶Ibid.

the sensible qualities and properties of objects; and when the consideration of these objects goes beyond the reach of the senses, then of course, the exercise ceases to be a development exercise, and becomes either an exercise of the memory or of some of the higher faculties.²⁷

Wilbur, then Superintendent of the State Asylum for Idiots, Syracuse New York, in an address to the National Association of Teachers, says:

The 'object system of instruction,' so called, was referred to at some length, and I indulged in some passing criticisms upon the peculiar method of instruction . . . which persons were laboring to introduce into this country. . . .²⁸

Wilbur further states:

. . . The errors into which I feared the over-zealous advocates of the 'object-system' might fall proved to be no chimeras. An evil, which, with the respect I felt for the American teachers, I then depreciated as somewhat remote, has become imminent. The 'Oswego System' is the new impress that is to give it currency on this side of the water.²⁹

Educational Theory.--Following the Pestalozzianism in America, came the educational theory of Herbart. Herbart's theorys supplement those of Pestalozzi's, while Pestalozzi offers sense-perception, he made no account of previous experience and the process of digesting intellectual thoughts.³⁰

²⁷Henry Barnard, American Pedagogy (Hartford, Brown and Gross, 2nd edition, 1876), p. 269.

²⁸H. B. Wilbur, Object System of Instruction, as cited in Henry Barnard's American Pedagogy, p. 474.

²⁹Barnard, op. cit., p. 474.

³⁰William J. Eckoff, Herbarts ABC of Sense-Perception (New York: D. Appleton and Co., 1896), p. viii.

Herbart offered an added dimension of sense-perception, spatial forms and measurements. In an attempt to describe a system, it was obvious that as a psychologist, Herbart was a novice but as a pedagogist he was an authority.³¹ McMurray explains that:

The theories of the Herbartians led to a more generalized approach and to a breaking down of subject matter boundaries.³²

Specialists of specific subject matter area were of the opinion that organized forms of subject matter context would lose certain inherent values when approached logically.³³

The history of educational theory had been thoroughly studied for the purpose of selecting the best theory appropriate for the need of the elementary science curriculum.

Motor activity and handwork were vehicles theory used to promote science activity. Dewey says:

The history of educational theory is marked by opposition between the idea that education is development from within and that is formation from without; that it is based upon natural endowments and that education is a process of overcoming natural inclination and substituting in its place habits acquired under external pressure.³⁴

³¹Ibid., p. 10.

³²Frank McMurray, "Concentration," Herbart Society, 1st Yearbook (1895), pp. 27-69.

³³William C. Bagley, The Educative Process (New York: MacMillan, 1922), p. 182.

³⁴John Dewey, Experience and Education (New York: MacMillan, 1938), p. 1.

The attitude concerning natural science in the elementary curricula was described by Harris by saying:

Natural science is only a superstition, because the pupil cannot see the relation between the various branches . . .³⁵

Another ill of the elementary science curricula was a lack of, and poor preparation of teachers. Parker writes:

. . . But it must be constantly borne in mind that the foisting upon the schools of studies, no matter how strong the argument is concerning their intrinsic value, have been, and always will be, a failure without the educated, trained, and competent teacher. . . .³⁶

McMurray showed the relationship of science to practical life in his revision of methods in science and says:

Our sole purpose is to show a certain degree of intelligence into these common observations of the uses of science, to awaken an intelligent interest in them, to prevent what is too common a feeling of blank amazement or even indifference in the presence of striking and valuable scientific achievements and objects . . .³⁷

As a personal justification for suggesting need for new directions in the elementary science curricula, Croxton makes the following observations:

. . . While the school is only one of the educational agencies, it can best assume leadership in bringing

³⁵William Harris, "Discussion" (NEA Proceedings, 1894), p. 624.

³⁶"Illinois Cook County Biennial School Reports" (1894), p. 65.

³⁷Charles A. McMurray, Special Methods in Elementary Science (New York: MacMillan, 1905), pp. 57-58.

about the interaction that makes for development--meriting instructing the child regarding his environment is insufficient--Rather his contacts with the environment ought to lead him to explore, experience, and achieve . . . in other words, to undertake something educational.³⁸

Realizing that the home played an important role as an institution vital to the development of the child, Croxton further states:

Children whose training at home and in school has been of this nature, tend to devise new games, make collections, tame and rear animals, grow plants, design dollclothes, construct, compose, paint, give plays, and engage in a great variety of creative acts during their leisure hours . . .³⁹

Contrary to the methods of traditional education found in schools, there is an apparent difference in the results of creativity found within the child.

Keating writes that earlier in the past, a similar need for environmental contact was expressed by Comenius in his argument for needed reform in the schools of his day.⁴⁰ Comenius argues:

From this precept it follows that the proper education for the young does not consist in stuffing their heads with a mass of words, sentences, and ideas dragged together out of various authors, but in opening their understanding to the outer world, so that a living stream may flow from their own minds, just as leaves, flowers, and fruit spring from the buds of trees, while in the following year a fresh

³⁸W. C. Croxton, Science in the Elementary School (New York: McGraw-Hill, Inc., 1937), p. 8.

³⁹Ibid.

⁴⁰Ibid.

bud is again formed, and a fresh shoot, with its leaves, flowers, and fruits grow from it.⁴¹

Comenius, as a result of his dissatisfaction with the process of the educational system, continues by pointing some failures of the schools:

Terrible deviation in schools, Hitherto the schools have not taught their pupils to develop their minds like young trees from their own roots, but rather to deck themselves with branches plucked from other trees and like aesops crows, to adorn themselves with the feathers of other birds. . . .⁴²

Jackman admitted the fact that his interest and concern for a new direction in science was both of a religious and an intellectual concern and felt that the study of nature would give the dimension back to the science curricula.⁴³ Croxton says:

perhaps the fact that nature study evolved from the reaction against the isolated object lessons and against the 'dry-as-dust' science teaching explains the emphasis that many of its advocates have placed on the development of desirable attitudes toward the environment, largely to the exclusion of other values.⁴⁴

Nature Study Movement.--Nature study was influenced by writings of Agassiz, Audubon and Ruskin. The naturalist was assumed to observe nature for personal enjoyment. Hall

⁴¹M. W. Keatings, The Great Didactic of Comenius (London: Adams and Charles, 1896), pp. 299-300.

⁴²Ibid.

⁴³Wilbur S. Jackman, "Nature Study and Religious Training," Educational Review, Vol. 30 (June, 1905), pp. 12-30.

⁴⁴Croxton, op. cit.; p. 25.

was one of the forerunners in this movement and stated that: "Science, art, literature, and religion rest upon love of nature."⁴⁵

New York State granted aid to Cornell University to produce materials for teachers and pupils to help them facilitate classroom activities.

Anna Botsford Comstock, wife of J. H. Comstock professor of entomology, at Cornell says:

When we began the work, seemingly so simple, of trying to introduce into our schools the study of the children's natural environment, we did not realize the weight and strength of the blank wall that we found confronting us. This wall was the prevalent educational system which was based on a curriculum that educated every teacher away from nature. . . .⁴⁶

The subsidized Cornell program was geared at preventing migration from the farms to an already overcrowded city. The Comstocks played a significant role in the nature study movement by furnishing teachers leaflets and later publishing the Handbook of Nature Study.

Throughout the nature study movement there were those who took opposition to both its philosophy/or results of its application.⁴⁷ The limitation as well as the

⁴⁵G. Stanley Hall, "The Function of Nature in Elementary Education" (NEA Proceedings, 1896), p. 157.

⁴⁶Anna Botsford Comstock, "Cornell Teachers Leaflet," Vol. 17, No. 1 (September, 1923), p. 44.

⁴⁷L. B. R. Briggs, "Some Aspects of Grammar School Training" (NEA Proceedings, 1901), pp. 320-330.

contribution of the nature study curricula was summed up by Bailey by saying:

Nature study is not a science, it is not knowledge. It is not fact. It is spirit. It is concerned with the child's outlook on the world.⁴⁸

Patterson writes:

Now if science is held to man in this connection method rather than matter there might be no dispute with this claim for science as a 'method of problem solving' begins even in nature study. But science as ordinarily used means organized knowledge in reference to nature. . . .⁴⁹

Although nature is composed of bits of botany, bits of zoology, physics, geology, etc., Patterson feels:

Any such organization of nature study would defeat its purpose . . . the sciences are all bound up in the great bundle of nature. . . . The attitude toward nature which nature study tends to engender would suggest that, with opportunity, nature study would pass into science as naturally as the boy into the man.⁵⁰

The disciples of the "nature study" movement by the 1920's had exhausted all of their enthusiasm for the movement, and new theorists began to make an impact on the science curricula.

New Direction in Science Curricula

The writings of James, which emphasized the methods of investigations, memory and observations, coupled with

⁴⁸L. H. Bailey, The Nature Study Idea (Garden City, New York: Doubleday, Page and Co., Inc., 1903), p. 6.

⁴⁹Alice Jean Patterson, Practical Nature Study and Elementary Agriculture (New York: D. Appleton and Co., 1909), p. 16.

⁵⁰Ibid., p. 7.

the consciousness of self and the stream of thought showed more pragmatical implications of organized investigations.⁵¹

James says:

Introspective observation is what we have to rely on first and foremost and always... . Introspective means looking into our own minds and reporting what we there discover. . . . Every one agrees that we there discover states of consciousness.⁵² . . . that we have cognition of some sort. . . . All people unhesitatingly believe that they feel themselves thinking, and that they distinguish the mental state as an inward activity of passion, from all the objects with which it may cognitively deal.⁵³

James describes five characters believed by him as found in thought, they are:

1. Every thought tends to be part of a personal consciousness.
2. Within each personal consciousness thought is always changing.
3. Within each personal consciousness thought is sensibly continuous.
4. It always appears to deal with objects independent of itself.
5. It is interested in some parts of these objects to the exclusions of others and welcomes or rejects . . . chooses from among them, in a word. . . . In considering these five points successively we shall have to plunge (in media res) in vocabulary.⁵⁴

Buchler maintains that the writing of Pierces argues:

⁵¹William James, The Principle of Psychology (Henry Holt and Co., 1890), pp. 65-355.

⁵²Ibid., p. 185.

⁵³Ibid., p. 225.

⁵⁴Ibid., p. 185.

. . . insofar as thought is cognitive, it must be linguistic or symbolic in character . . . (i.e., it must presuppose communication) . . .⁵⁵

Pierce introduced in his theory pragmatism operations such as, how to make over ideas clearly; philosophy of logic; the principles of phenomenology and found it difficult to secure a regular teaching position, however, his effects showed up in other thinkers.⁵⁶ Royce, James and Dewey demonstrated the Piercian philosophy.⁵⁷ Smith states that the works of James, Pierce, and Dewey contributed greatly to the eventual development of the inquiry approach in science in the 1930's.⁵⁸

Craig in his study of elementary science curricula, found that:

. . . one of the facts first noted was a difference in terminology. The majority of the schools teaching natural science as a separate subject use the term 'nature study.' A few schools are introducing the term 'elementary science' to include all of the natural science taught.⁵⁹

Craig further stated:

Nature study in the elementary school has probably never developed a functional organization. . . .

⁵⁵Ibid., p. 225.

⁵⁶Ibid.

⁵⁷Justus Buchler, Philosophical Writings of Pierce (New York: Dover Publications, 1955), p. xi.

⁵⁸Ibid.

⁵⁹Gerald S. Craig, "Certain Techniques Used in Developing A Course of Study In Science for the Horace Mann Elementary School" (New York: Teachers College, Columbia University, 1927), p. 2.

This lack of organization has been commented by some who felt that an organized nature study program would tend to kill all spontaneous expression on the part of teacher and pupils. . . . Thus nature study came to be . . . merely a disconnected series of object lessons. . . . The lack of organization in the content in this field has definitely interfered with the successful teaching of science.⁶⁰

It was concluded by Craig that the selection of goals is an important task in curriculum instruction.⁶¹

A similar study was done by Meier in which she concluded:

A significant contribution in the field of curriculum construction was made by Dr. G. S. Craig. . . . The content of the course of instruction was selected on the basis of a list of objectives: (1) which conformed to scientific conceptions that influence the thought reaction of the individual and modify thought, (2) which supply information essential to effective social life, (3) which help in interpretation of natural phenomena?⁶²

Meier further states:

The large conceptions or 'big ideas' of science which contribute to the objectives are drawn from the major scientific fields, since professional studies have indicated that the child's interest and needs are in the fields of physical science as well as biological science.⁶³

James in stressing the necessity of reactions states:

The older pedagogic method of learning things by rote, and reciting them parrot-like in the classroom, rested on the truth that a thing merely read or heard, and never verbally reproduced, contracts

⁶⁰Ibid.

⁶¹Ibid., pp. 2-3.

⁶²Lois Meier, "Natural Science Education in the German Elementary Schools" (New York: Teachers College, 1930), p. 146.

⁶³Ibid.

the weakest possible adhesion in the mind. Verbal recitation or reproduction is thus a highly important kind of reactive behavior on our impressions; and it is to be feared that in the reaction against the old parrot-recitations as the beginning and end of instruction. . . . The extreme value of verbal recitation as an element of complete training may nowadays be too much forgotten.⁶⁴

In 1932, an important forward step took place in science education. The Thirty-first Yearbook of the National Society for the Study of Education was published. The following statements represent the generalizations of that publication:

The major generalization and associated scientific attitudes are seen as of such importance that understanding of them are made the objectives of science teaching. These statements are so far reaching in their implications that they may be said to encompass the field of science. They touch life in so many ways that their attainments as educational objectives constitute a large part of the program of life enrichment.⁶⁵

The generalization further suggests that:

In the light of the foregoing it is proposed that the curriculum in science for a program of general education be organized about large objectives, that understanding and enlargement of the objectives shall constitute the contribution of science teaching to the ultimate aim of education, and, that the course of study be so organized that each succeeding grade level shall represent an increasingly enlarged and increasingly mature development of objectives.⁶⁶

⁶⁴William James, Talk to Teachers on Psychology (Cambridge, Mass.: University Press, 1896), p. 34.

⁶⁵National Society for the Study of Education, "A Program for Teaching Science," Thirty-first yearbook, Part I (Bloomington, Indiana: Public School Publishing Co., 1932).

⁶⁶Ibid.

The tremendous amount of research devoted by the NSSE in National Society for the Study of Education to identifying major principles of science and their relationship to general education following the publication of this yearbook, demonstrated the strong influence that it had on educators and researchers.⁶⁷ Two subsequent yearbooks published by the Society, focused attempts on bringing the content material of the earlier published yearbook (Thirty-first) up-to-date and placed continuing emphasis on the importance of science education in a society becoming increasingly more dependent on the products of science and technology.⁶⁸

Reactions and Expressions to the Forty-Sixth and Fifty-Ninth Yearbook

Barnard, Part I of the Forty-Sixth Yearbook (1947)

says:

Science education in American schools urged further recognition of fundamental values in the advancement of scientific knowledge as well as in the improvement of science education.⁶⁹

Published critiques of the Fifty-ninth Yearbook, Part I, Rethinking Science Education has been offered by Atkins who says:

⁶⁷Ibid.

⁶⁸National Society for the Study of Education, "Science Education in American Schools," Forty-Sixth Yearbook, Part I (Chicago: University of Chicago Press, 1947).

⁶⁹National Society for the Study of Education, "Rethinking Science Education," Fifty-Ninth Yearbook, Part I (Chicago: University of Chicago Press, 1960).

Shamos (p. 2-7) quotes Poincaré and implies that the best science study immerses one deeply into the discipline; he says that impression of science based on its social utility are false impressions.⁷⁰

Atkins expresses his delight with the yearbook by concluding that:

All contributors seem to share the view of one, that science is a 'search for order in nature' and that science education should place greatest stresses on the 'search.'⁷¹

He praises the Fifty-ninth yearbook by referring to it as:

. . . certainly the most significant contribution to the general literature of science education in more than a decade.⁷²

Bayles wondered somewhat whether the title of the yearbook "Rethinking Science Education" was justified, he says:

. . . I find shortcomings much like those I found in the Thirty-First yearbook and on which I commented in two different articles in 1932. . . . Let us be specific. The title of Chapter III is "How the Individual Learns Science."⁷³

Bayles confused by undefined terms says:

After several pages liberally interspersed with a profession of undefined terms such as 'concepts,' 'meanings,' 'generalization,' 'inductive method,' 'deductive approach,' 'percepts,' 'conceptual thinking,' 'critical thinking,' 'productive thinking,' 'problem solving,' 'judgment,' 'scientific method,' etc., we are then taken to statements such

⁷⁰Myron Atkin, "Critique A--The Fifty-Ninth Yearbook," Part I (Chicago: University of Chicago Press, 1960). "Rethinking Science Education," Science Teacher, Vol. 27, No. 4 (May, 1960), p. 9.

⁷¹Ibid.

⁷²Ibid.

⁷³Ernest Bayles, "Critique B--The Fifty-Ninth Yearbook," Part I (Chicago: University of Chicago Press, 1960); Science Education, p. 10.

as: 'The principle of learning which are to be observed in teaching directly for the attitudes and methods of science are the same as those applicable for any other educational objective,' and 'The experience should be psychologically sound, with due cognizance given to aims and needs.'⁷⁴

Bayles asks seriously:

How non-committal can one get? . . . I submit that in this entire chapter, there is no enlightenment on how an individual learns science. . . . I am forced to report that I find the Fifty-Ninth Yearbook disappointing.⁷⁵

Past History Summary.--Staley summarizes the past history of elementary school science by concluding that two important features were revealed in his study.

1. Although many of the teaching practices and underlying philosophies of past elementary school proceed to be impractical or unsound, there were some characteristics of past elementary school science which withstood the advances in social, economic, scientific, technological, and educational thought and practice. These were the methods, procedures, and ideals which characterized much of present elementary school sciences.
2. One of the apparent reasons for the failures of many of the past approaches to the teaching of elementary school science was the teachers lack of understanding of the underlying philosophies and lack of skill needed to implement these programs.⁷⁶

⁷⁴Ibid.

⁷⁵Ibid.

⁷⁶Frederick Allen Staley, "A Comparison Study of The Effects of Pre-service Teachers Presenting One or Two Micro-Teaching Lessons to Different Sized Groups of Peers on Selected Teaching Behaviors and Attitudes in an Elementary Science Methods Course" (unpublished Ph.D. dissertation, Michigan State University, 1970).

He further concludes, that among these surviving practices and ideals are the beliefs that: (a) children should be provided with real experiences, (b) children should be actively involved in science activities, (c) the structure of the elementary science program should be interdisciplinary in nature, and (d) elementary school science consists of learning the products of scientific endeavors as well as the methods used by scientists to discover and study science.⁷⁷

Recent Trends in Elementary Science Curricula

Blackwood bewails the fact, that to improve the teaching of sciences, or just to keep it alive, curricula innovations are encouraging science teachers to learn the analytical nature of teaching; they must learn to become able to present science material in an orderly organized fashion.⁷⁸ Curricula innovators feel that a rich program in elementary science over a period of years would help each pupil understand major concepts that are descriptive of the best that is currently known about the physical and biological worlds.

Emphasis then, it is thought, must be placed on learning concepts of science. All of the new project

⁷⁷Ibid.

⁷⁸Paul E. Blackwood, Introduction (Haney, 1966), p. vi.

curriculum, have placed emphasis on student involvement in science. Blackwood claims that curricula innovators believed the use of student involvement would help students learn how knowledge is discovered and validated in the different sciences:

They will come to understand that scientists uncover knowledge in different ways. They will learn to use some of the methods of investigations, inquiry and discovery that scientists use. Hopefully, pupils will have their own behavior change as a result of the study of science. They will be able to do certain things better for having studied science, better investigating, better observing, better experimenting, better thinking.⁷⁹

Apparently, student attitudes associated with science discovering and validating knowledge were considered important outcomes of studying science. The stated purposes and desired attitudes of our new programs, appeared in varying degrees and in different forms. Blackwood says that the objectives of the programs were highly desirable by scientists, psychologists, college professors and classroom teachers involved in developing the program.⁸⁰

Although productive change, with a reasonable guarantee in increase in the quality of a product, is a desirable commodity for any consumer, Blackwood had strong feelings about the excessive amount of stress being placed on the claim that science teaching would achieve such a multiplicity of objectives in the general education of

⁷⁹Ibid., p. vi.

⁸⁰Ibid., pp. vi-vii.

students.⁸¹ The United States Office of Education during the 1961-1962 academic year compiled a list of ten commonly accepted objectives of elementary science teaching. Using the returns of a national sampling of more than 87,000 elementary schools, the results concluded that the first nine objectives were "very important." The objectives were ranked in the following priorities:

1. To help pupils develop curiosity.
2. To help pupils learn to think critically.
3. To introduce pupils to typical science; topics such as weather, electricity, and plant and animal life.
4. To help pupils acquire knowledge of their environment.
5. To help pupils develop an appreciation of their environment.
6. To develop problem-solving skills.
7. To develop in pupils a sense of responsibility for the proper use of science.
8. To prepare pupils for high school science.
9. To develop hobbies and leisure time activities.

While only seventeen per cent of the school considered it "very important" a tenth objective was listed:

10. to develop scientists.

Effects of Sputnik--Myth or Fact.--Sputnik played a role in increasing public awareness of general educational

⁸¹Paul E. Blackwood, "Science in the Elementary School," Readings in Science Education for the Elementary School, ed. by Edward Victor and Marjorie Lerner (New York: The MacMillan Co., 1967), pp. 42-43.

ills, but probably was not the prime mover that it has often been thought to be.⁸² However, the scientific community quickly focused upon the ills of science education.

John Newport attempted to determine whether the recent activity in elementary science was being accompanied by changes in the objectives for elementary science as well as to determine which objectives of elementary science most writers would agree upon.⁸³ After reviewing the objectives from the 1930's to the time of Sputnik's impact, it was found that they differed only in semantics. During the early 1930's, one of the purposes of science was to "increase the child's curiosity." Today teachers are encouraged to "develop an attitude of inquiry."⁸⁴ There were six objectives which showed a continuous existence in sources reviewed by Newport. These were arranged in order of frequency:

1. Develop scientific methods as a way of thinking and solving problems.
2. Develop understanding of the child's environment and his relationship to the physical world.
3. Develop scientific attitudes.
4. Develop the fundamental skills of measuring, observing, organizing and classifying, manipulation and communication.

⁸²Richard Haney, "The Changing Curriculum: Science Association For Supervision and Curriculum Development" (NEA, November, 1966), p. 359.

⁸³John F. Newport, "Are Science Objectives Changing?" School Science and Mathematics, LXV (April, 1965), pp. 359-362.

⁸⁴Ibid., p. 359.

5. Develop an appreciation of the contributions of science and of the work of scientists.
6. Develop interest for leisure time activities.⁸⁵

The conclusion was drawn by Newport that:

Reverberations from the Space Age may have partly been responsible for the development of new science curriculum materials, but a close examination of science objectives provided no evidence that a change in objectives was occurring. Objectives stated in the 1930's seem to have survived a world war, the coming of the Atomic and Space Ages, numerous social changes, and some changes in teaching methods, science content, and other phases of science education. This study indicated that the new science materials currently being developed have probably resulted from general dissatisfaction with science teaching at the elementary school level rather than from the formulation of new purposes of science education.⁸⁶

National Science Foundation Funded Elementary Projects

John Newport wrote after a national study had been conducted by the United States Office of Education that ". . . inadequate teacher training" continues to plague elementary school science.⁸⁷ Returns from the national survey showed that practices in elementary science, resulting from a lack of supplies, was ranked second of the thirteen items listed according to rank of barriers received from the sampling. The next significant ranking

⁸⁵Ibid., pp. 361-362.

⁸⁶Ibid., p. 362.

⁸⁷John F. Newport, "Its Time for A Change," School Science and Mathematics, LXV, No. 8 (November, 1965), pp. 725-728.

was do not know method, which was strengthened enough to support the claim of inadequacy in teacher training.

It was felt by Newport that the frustration level would increase as a result of the new science curricula.⁸⁸ The curricula basically stressed active participation by each student. Newport ranked the curriculum projects in order of greatest demand for equipment usage among several curriculum projects. The order is as follows:

1. Science Curriculum Improvement Study.
2. Elementary School Science project.
3. Elementary Science Study.
4. American Association for the Advancement of Science.⁸⁹

Newport feels that:

It is obvious that the amount of success of the new elementary curricula projects depends largely upon the extent of adoption of the materials by classroom teachers. If the lessons in the new material are evaluated on the basis of 'Will many teachers be able to accumulate the equipment needed to teach the lesson?'⁹⁰

He concludes by arguing:

. . . If the new science programs are to escape the change recently made against the new math, that is ' . . . little more than a status symbol used . . . ' to obtain grants for educators to maintain prestige, publishers to sell books.⁹¹

⁸⁸ Ibid., p. 726.

⁸⁹ Ibid.

⁹⁰ Ibid.

⁹¹ Ibid.

If so, than he says:

Some provision must be made for supplying teachers with the equipment needed to implement the programs. . . . If the full value of the new program is to be realized, the agencies funding the development of the programs will have to provide schools with more assistance in obtaining the equipment . . .⁹²

AAAS Cooperative Committee.--It was disclosed by Bikle that the basis of the cooperative committee of the AAAS, which began back in 1940 working through the war years, furnished the United States Government with necessary data for establishing the National Science Foundation funding episode.⁹³ The most ambitious undertaking of the committee, and the one that has had the most far reaching effects of directly attributable activities of the committee, says Bikle, was the development of what was first called an "Action program to meet the shortage of well qualified science and mathematics teachers."⁹⁴

The Science Teachers Improvement Program (STIP) consisted of six major projects, Bikle listed them as follows:

1. To encourage departments of science and mathematics in colleges and universities to accept the training of secondary school teachers as a major responsibility.
2. To increase the number of qualified teachers on an emergency basis.

⁹²Ibid.

⁹³Charles L. Bikle, "AAAS Cooperative Committee Celebrates Twenty-fifth Anniversary," The Science Teacher, Vol. 33, No. 4 (April, 1966).

⁹⁴Ibid.

3. To interest high school students in preparing for teaching careers in science and mathematics.
4. To support higher wages for teachers.
5. To promote improved working conditions for an increased efficiency of secondary school teachers of science and mathematics.
6. To provide for the recognition of exceptionally able teachers.⁹⁵

Bikle concludes that:

The cooperative committee deserves a large measure of the credit for keeping alive an interest in science teaching problems during the lean years when this was not popular, and for encouraging individual scientists and professional societies to engage in efforts toward the improvement of science teaching.⁹⁶

Robinson says the question of major concern for the Harvard Committee was:

How can general education be so adapted to differing abilities and outlooks, that it can appeal deeply to each, yet remain in goal and essential teaching the same for all.⁹⁷

This concern was expressed while the consideration of the problem of general education was being discussed for possible solution by the committee. "The question as it arises to science curricula remains to be resolved" says Robinson.⁹⁸

⁹⁵Ibid.

⁹⁶Ibid.

⁹⁷James T. Robinson, The Nature of Science and Science Teaching (Belmont, California: Wadsworth Publishing Co., Inc., 1968), p. 3.

Morrison and Walcott's writings on the Elementary Science Summer Study show improvement in curricula diversity and is aimed at meeting the demands of this curricula dilemma. They say:

The teaching of science to children should not in fact be done to make them all scientists, but to encourage scientific literacy in the population.⁹⁹

The report revealed that the major aim of the ESS Project was to encourage children to examine the world around them and to acquire the desire, interest, and ability to continue to analyze, relate, and understand it as they go through life.

It is felt by the ESS curriculum innovators that there is a certain diversity within the program which takes into account the affectiveness of the pupils.

. . . it allows for the plurality of the problem, the many sidedness, the methods, the aims, and the people affected.¹⁰⁰

Morrison and Walcott conclude that:

1. The great disparity between the diversity of the goal and the singleness of the means, found in so many other efforts to improve the science curriculum was almost totally absent in their summer writing sessions. . . .
2. Given the philosophy of 'enlightened opportunism' i.e., opportunism in the sense that, given the context of the child's interest, the child's age--the level of machinery which surrounds him in the home, from the TV set to the water faucet, given all these things at which point do we see physical, biological, or other systems which

⁹⁹Ibid., p. 49.

¹⁰⁰Ibid.

attract attention and which can lead to some growth and understanding for inquiry.¹⁰¹

Walbesser as a result of a study using behavioral objectives with the elementary program of the American Association for the Advancement of Science curricula says that:

activities which have a high probability of shaping those behaviors which reflect the underlying processes of science should be the primary focus of the construction of any materials.¹⁰²

It was further stated by Walbesser, that materials predicted on the "process of science" in a science curriculum should show direct steps in identifying the set of processes being considered.¹⁰³ Walbesser claims:

If a particular curriculum project claims to have accomplished something, then one of the most fundamental obligations of the experimenter is to present evidence of change or proof of learning. . . . If the learner is told what he 'will be able to do' after the exposure to curriculum material then proof can be ascertained by a assessment.¹⁰⁴

Walbesser firmly declares that human performances is another aid in curricula measurement and behavioral description that are clarified, i.e., (1) naming,

¹⁰¹Ibid., pp. 52-53.

¹⁰²Henry H. Walbesser, "Curriculum Evaluations by Means of Behavioral Objectives," Journal of Research in Science Teaching, Vol. 1 (1963), pp. 296-301.

¹⁰³Ibid., p. 298.

¹⁰⁴Ibid., p. 299.

(2) identifying, (3) recognizing, (4) distinguishing, (5) describing, (6) ordering, will yield maximum results.¹⁰⁵

Although the six items listed by Walbesser are the results of the psychology of Gagné; Gagné discusses enquiry as a kind of activity that scientists engage in and consequently it represents one of the most essential objectives of science instruction.¹⁰⁶

According to Gagné, the traditional program does show deficiencies in so far as it fails to inform the students of the elements of the enquiry method. Gagné makes the following three concluding statements:

1. It must be quite clear that 'practice in inquiry' for the student of science has great value, but to be successful it must be based upon a great variety of prerequisite knowledges and competencies which themselves are learned, sometimes by 'discovery' but inconceivably by what is called 'enquiry.'
2. . . . it seems to be totally erroneous to look upon these early attainments as having anything but a specious resemblance to the activities of disciplined enquiry, or to contend that they can be acquired by practice in 'inquiry.'
3. One doesn't learn to be a scientist, or to appreciate science by pretending to be a scientist. What is the difference in principle, between trying to 'practice enquiry' in the second grade, and trying to practice 'being a physician at the same age level.'¹⁰⁷

¹⁰⁵Ibid., p. 301.

¹⁰⁶Robert Gagné, "The Learning Requirement for Enquiry," Journal of Research in Science Teaching, Vol. 1 (1963), pp. 144-153.

¹⁰⁷Ibid., p. 145.

Elementary School Science Projects

Mason says that concept formation is the major concern in training children to understand science as well as to construct the knowledge of science logically and mathematically.¹⁰⁸

Mason stated that definitions are adequate in science, but will serve the same purpose as concepts when applied to logical relationships.¹⁰⁹ He stands firmly on the statements that:

The confidence of our people in the scientific method must rest secure in the knowledge that it represents thorough logical analysis of the relations of data which in turn yield the most effective basis of correlation between the logical system of the science and mathematical models of its theory. . . . The knowledge of these rudiments are thus fundamental to literacy to science.¹¹⁰

Illinois Astronomy Project.--John Newport evaluated the Illinois Astronomy series and reports the following findings:

Book One--Charting the Universe, Book Two--The Universe in Motion and Book Three--Cravitation might be used in grades five through eight, however this may not be the level of appropriateness for the material.¹¹¹

¹⁰⁸Herbert L. Mason, "Formal Relations in Elementary School Science," Science Education, Vol. 50, No. 2 (March, 1966), pp. 166-169.

¹⁰⁹Ibid., pp. 166-167.

¹¹⁰Ibid., p. 169.

¹¹¹John F. Newport, "A Look at the University of Illinois Astronomy Materials," School Science and Mathematics, LXV, No. 2 (February, 1965), pp. 145.

Newport reports the following observations:

Book one probably should not be used before grade five and possibly not until junior high school. Books two and three do not call for nearly as much computation as book one does, but book two and three do call for an understanding of certain principles of mathematics which appears to be rather difficult for elementary school pupils.¹¹²

It is also claimed by Newport regarding the readability of the project material:

. . . If the technical words are removed from the texts, a readability level 6.9 which was too difficult for sixth graders, would drop down to a readability level of 2. The question is can the teacher teach the material.¹¹³

Newport further states:

Considering the inadequate preparation of many elementary teachers in both science and mathematics, it is probable that not too many teachers would be too enthusiastic about teaching the material in its present form.¹¹⁴

Furthermore he contends:

The three units indicate that it is possible to write about a concept on an elementary level, but when developing the concept mathematically one finds that he is dealing with mathematics that may be more appropriate for the junior and senior high school level. The units serve well to explain why much of the science in the elementary schools today is descriptive.¹¹⁵

MINNEMAST.--Rising writes the following about

MINNEMAST:

¹¹²Ibid., pp. 146-147.

¹¹³Ibid., p. 146.

¹¹⁴Ibid.

¹¹⁵Ibid., p. 147.

. . . this is an elementary curricula project funded by the National Science Foundation, U.S. Office of Education, Control Data Corporation, The Hill Foundation and the University of Minnesota and others.¹¹⁶

Rising states that the curriculum and its hardware used in the elementary science curricula requires teacher training workshop and In-service activities to teach the teachers the background and operational processes needed to teach the curriculum.¹¹⁷ Although the university furnishes in-service and pre-service method courses, says Rising, it does not satisfy the overwhelming demand for teachers needing these courses so that they can become astute in the content, the method and the activities of the program.¹¹⁸

Effects of Forced Learning on Children.--Hess takes a look at the effects of subjecting children of early ages to complicated tasks. He is convinced that both educators and psychologists have assumed:

. . . that there is a confluence of factors which creates an optimum time for teaching specific skills and concepts.¹¹⁹

¹¹⁶Ibid.

¹¹⁷Gerald R. Rising, "Research and Development in Mathematics and Science Education at the Minnesota School Mathematics Center and the Minnesota National Laboratory," School Science and Mathematics, LXV, No. 19 (December, 1965), pp. 811-820.

¹¹⁸Ibid., pp. 813-816.

¹¹⁹Robert D. Hess, "The Latent Resources of the Child's Mind," Journal of Research in Science Teaching, Vol. 1 (1963), pp. 20-26.

This view, Hess says, received most of its impact early from forced learning. It is thought by Hess that experimental studies which teach skills are hoping that early training would have more permanently increasing effect upon the child.¹²⁰ His research has shown that special training in motor skills, academics, involving foreign language and other mental abilities, predicated on memory, while the child is young has often to be relearned at a later period in life.¹²¹ Hess concludes that:

1. . . . potentialities of the human mind as genetically determined do not unfold naturally and evitably, but require active participation of a stimulating environment.
2. . . . It is important that this stimulation occur as early as possible in the child's experience.
3. The range and variety of early experience directly affects the possibilities of later learning and sets limits to the flexibility and adeptness of the adult mind by limiting or expanding the network of concepts, meanings, and symbols through which the individual experiences the world.¹²²

Biological Assessment.--Cunningham conducted an assessment of biology in the elementary science curricula. Four curricula projects were selected by Cunningham for the assessment, they were:

1. Science Curriculum Improvement Study,
2. Elementary Science Study,

¹²⁰Ibid., p. 21.

¹²¹Ibid., pp. 21-22.

¹²²Ibid., pp. 24-26.

3. Science A Process Approach--American Association for the Advancement of Science,
4. Elementary School Science Projects.¹²³

Cunningham finds that in the elementary science programs none of the biological programs is completely different from the trend already found in elementary school science itself. He offers several alternatives to improving the effectiveness of the application of the material in an order to move effectively realize the objectives of the material.¹²⁴ Cunningham says that:

. . . in the study of internal factors as are inferred in the SCIS section on organism, will not have any meaning to any elementary students until he has had several years of study on how organisms grow.¹²⁵

He is of the opinion that in the ESS units: "messing around" becomes:

a way of working that is no longer childish, though it remains always childlike, the kind of self-disciplined probing and exploring is the essence of creativity.¹²⁶

In the Science A Process Approach or AAAS curriculum, Cunningham notes that:

Young children emphasis are focused upon items such as how the observer utilizes his senses to become aware of his environment.¹²⁷

¹²³John D. Cunningham, "New Developments in Elementary School Biology," The American Biology Teacher, Vol. 28, No. 3 (March, 1966), pp. 193-198.

¹²⁴Ibid., p. 195.

¹²⁵Ibid., p. 196.

¹²⁶Ibid.

¹²⁷Ibid., p. 197.

Finally, in the elementary school science project units, Cunningham says that they are designed:

. . . to demonstrate scientific method, however, the materials are not organized by the process employed, but rather by the structure of the subject matter treated.¹²⁸

Butzow in his in-service and pre-service work with teachers feels that teachers who were exposed to project materials grasped the feeling of excitement when phenomena were observed directly, they did not feel a personal commitment to much change in their teaching methods. Butzow says:

Teachers need to more fully understand that the newer elementary school science was designed more to help children manipulate materials, observe phenomena, and build their own explanations than to learn scientific interpretations and terminology as such . . . many teachers and administration do not yet realize that science at most levels of sophistication is an activity. . . .¹²⁹

The school wide or district wide science curriculum usually does not decide in favor of the modern curriculum programs because the curriculum committee membership is dominated by what Butzow calls "traditionists." They usually offer the following objections to curricula project designs:

1. Elementary science study does not present a sequential curriculum in which the major ideas of science are stressed.

¹²⁸Ibid., p. 198.

¹²⁹John W. Butzow, Jr., "Why the 'New' School Science Doesn't Sell," Science and Children, Vol. 10, No. 6 (January-February, 1973), pp. 20-22.

2. Science a process approach does not stress the topics of science but jump from physics to biology--this confuses me.
3. Science curriculum improvement study does not give the same coverage of all the science concepts I have always held as important.¹³⁰

Butzow concludes:

1. The curriculum committee sees the elementary program as fundamental to building the facts and concepts used later in high school and college. The National Science Foundation programs seem too loosely organized to obtain that kind of learning.
2. The National Science Programs are far less futuristic in terms of preparation for more formal programs of conceptual and factual science.
3. The National Science Foundation programs were developed for the child as he is now, rather than as he will be later. They all attempt to help the child develop skills he can use as a child.¹³¹

Governmental Reaction and Effects on Existing Science Projects

Shapley notes that the shape of the new role of science being supported by governmental agencies are changing. The details of plans for this change, however, is still in a state of flux. Shapley writes:

. . . the job of chief scientists in government would be transferred to the director of the National Science Foundation . . . the Office of Science and Technology will be dismembered in one way or another and the principal players will be White House Aides with no special affiliations with science. . . .¹³²

¹³⁰Ibid., p. 21.

¹³¹Ibid.

¹³²Debora H. Shapley, "Science in Government: Outline of New Team Emerges," Science, Vol. 179, No. 4072 (February 2, 1973), p. 455.

Shapley continues by pointing out:

. . . the formal resignation of the President's Science Advisory Committee will be accepted . . . the new NSF role came from Congressional sources and is based on a private briefing to NSF's overseers, the National Science Board . . . which will be expanded to include more industry oriented and technology oriented members. . . . Science policy will now be made not by top ranking scientists but by young Republican lawyers. . . .¹³³

The reaction of a Democratic science staffer to the Office of Science and Technology was described thusly:

. . . the whole thing has been a charade since Horn-ing (the late President Johnson's science advisor).¹³⁴

A final statement of discontent was made by a high White House official who says the following about the "dismembering" of the Office of Science and Technology:

. . . all you'd be getting rid of are a batch of guys who massage reports.¹³⁵

Shapley feels that due to two possible conflicts of interest the National Science Foundation will face difficulty in obtaining a broad mandate to advise the White House on science policy:

1. NSF Director Stever, will be advising on the research funds for federal agencies, while his own agencies compete for its share of its budgetary pie.
2. From a policy standpoint, the best Presidential science advice is thought to have to be independent of agency self-interest.¹³⁶

¹³³Ibid.

¹³⁴Ibid.

¹³⁵Ibid.

¹³⁶Ibid.

Walsh feels that the reorganization of the science advisory structure does more than reshape the advisory boards of science, it also deteriorates the special relationship developed with Presidents since the time of World War II. He further suggests that the extent of the "downgrading" of science cannot be determined until the new organization begins to function.¹³⁷ Walsh states that proponents of the NSF, saw their position as possibly becoming:

. . . a ministry of science, making science policies and coordinating science programs for the rest of the federal government.¹³⁸

Although this challenge was never accepted by the NSF, Walsh gives two possibilities as to why the NSF failed to do so:

1. . . . NSF officials wanted no part of assuming major responsibility without real authority to discharge them.
2. . . . agency policy faithfully reflected the wishes of the scientific community that NSF should foster and protect basic research and leave the support of costly and potentially controversial applied research and development to mission-oriented agencies.¹³⁹

Walsh presents evidence of the number of departures from "policy-level" jobs without replacement. He shows

¹³⁷John Walsh, "Federal Science: Filling the Blanks in Policy and Personnel," Science, Vol. 179, No. 4072 (February 2, 1973), pp. 456-458.

¹³⁸Ibid., p. 456.

¹³⁹Ibid., p. 457.

that out of 30 top government science jobs, more than half are vacant. The changes and new appointments are shown in the following chart (see Chart 1). Walsh concludes:

. . . For the moment it is true, if trite to say that the thing to watch is not the reorganization charts, but the shape of the science budget and the quality of the Administration's appointees.¹⁴⁰

Walsh writes:

It was during Truman's Presidency that wartime cooperation between scientists and the military was institutionalized of the new civilian science agencies, the most symbolic, though not the first, was the National Science Foundation. Now there are signs that these established relations, too, are being reappraised and revised.¹⁴¹

Walsh says that during the centennial meeting of the AAAS in September 1948, Truman made reference to the following recommendations, which had been submitted to the 80th Congress, they were:

1. . . . We should double our total public and private allocations of funds to the sciences.
2. . . . greater emphasis should be placed on basic research and on medical research.
3. . . . A National Science Foundation should be established.
4. . . . more aid should be granted to the universities, both for student scholarships and for research facilities.
5. . . . the work of the research agencies of the Federal Government should be better financed and coordinated.¹⁴²

¹⁴⁰ John Walsh, "Box Score: Hired, Fired, Retired," Science, Vol. 179, No. 4072 (February 2, 1973), p. 457.

¹⁴¹ Ibid.

¹⁴² Ibid., p. 263.

GOVERNMENTAL STRUCTURE REORGANIZATION CHART

Positions	Number	Action Taken				
		*	**	***	*+	**+
Directors	6	1	-	1	1	3
Assistant Directors	2	-	-	-	2	-
Deputy Directors	3	-	1	-	1	1
Chairman	2	-	-	1	-	1
Secretary	1	-	-	1	-	-
Undersecretary	1	-	-	1	-	-
Deputy Undersecretary	1	-	-	1	-	-
Assistant Secretary	1	-	-	1	-	6
Deputy Assistant Secretary	1	-	-	-	-	1
Commissioners	2	-	-	2	-	-
Official	2	2	-	-	-	-
Surgeon General	1	-	-	1	-	-
Presidential Assistant	1	1	-	-	-	-

* Appointed

*+ Remained

** Promoted

**+ Resigned

*** Reassigned

Walsh makes the following statements about area studies:

The federal program that has provided funds for the support of . . . area studies programs in major universities for the past 15 years is reportedly a disaster area in the forthcoming budget . . . Rumors

are rampart that the education budget will show heavy reductions across the board. . . .¹⁴³

Walsh concludes by saying:

So it seems that with less hyperbole than usual it can be said that Truman's death by coincidence, marks the end of the era which he did so much to shape.¹⁴⁴

This abridged chart represents the number of departures from the "policy level" government science jobs. The raw material was furnished by Walsh.¹⁴⁵ A more detailed chart presenting the same basic information may be found in the Appendix. The justification for this chart arises from the recent cutback and restructuring of Federal Government staff, under whose jurisdiction the funds for Federal Government staff, under whose jurisdiction the funds for Federal projects have come. This chart suggests by its reorganizational set up that all nonproductive agencies and programs have been "axed" in favor of "productive assessible programs" as printed in the magazine Science, Vol. 179, January 19, 1973.

Summary of Recent Projects

In the literature research, for this area of endeavor, little evidence was presented that the National Science Foundation funded curricula projects increased

¹⁴³ John Walsh, "Area Studies Under the Axe," Science, Vol. 179 (January 19, 1973), p. 263.

¹⁴⁴ Ibid., p. 265.

¹⁴⁵ Ibid.

the effectiveness of accomplishing a multiplicity of objectives in the general education of students. Moreover, within the same program, there was no evidence that all of the new curricula project students could "apply knowledge to solve daily problems," generate "the ability to communicate effectively," promote "conceptual thinking," to do "problem solving," "to work together effectively," "to understand and appreciate the way scientists think," "to promote the process of enquiry," "to promote scientific literacy," and other vacuous phrases of the sort.

Again, there was no noticeable measure of any change in the pupil studying the new curricula, other than the fact that the new curricula was helping them understand science. There was no available research which emphatically concludes that the new curricula developed a significant difference in the ability of pupils to do anything different than to achieve in science over and above any previously used curricula as vacuously claimed by the aforementioned objectives in the first paragraph.

The research questions the claims that the increased use of equipment demanded to effectively implement and support the curricula, did more to increase the frustration level of teachers who were termed as inadequately prepared or science shy. The equipment presented much more of an internal threat to the curricula itself, when an adopted program was inadequately equipped to effectively execute the investigations designed within the curricula.

Most curricula project developers were overly anxious in developing materials for the projects. However, the materials developed were in most cases far too complicated in design and unsuccessful in being matched to the capabilities of the children for whom they were prepared. Often the first, second and third "editions" of materials were necessary. The wealth of money, time spent producing and redesigning of in-service and pre-service methods suggest that the teachers themselves were less than anxious to teach the curricula programs.

The same kinds of ills prevalent in the 1930's are also seen in today's new curricula.

1. Inadequately prepared teachers.
2. Lack of specific measureable purpose.
3. Lack of understanding of philosophy and psychology upon which programs were predicted.
4. The failure of activity-centered programs to be able to show a measureable increase in learning.

The failure of the programs to realize their objectives and purposes suggests that a different vehicle might be more successful if used for elementary science instruction.

While it might be a little premature to judge the effectiveness of the new curricula at this time, a project curricula participant still might show signs of curricula influence by the time he reaches adulthood.

With the redesigning of the structure of the federal sources of support of the new programs, the more than 106 centers and 63 universities previously receiving support will suffer severe budget cuts when the axe is lowered. The rationale used for the budget cut; that which proports that the money severed would be used for a more effective and efficient purpose, suggests that the effectiveness of the overall result of the 106 area centers and the some 63 universities does not warrant the spending of the millions of dollars on the many curricula projects which have been previously supported.

Other significant factors which stifled the success of the curricula projects were:

1. The inability of exceptional well-trained science teachers to understand the intent of the "new" curricula.
2. The loosely organization of the "new" curricula.
3. The non-sequential arrangement of subject matter context to the point that it was understood by the majority of science teachers, curriculum committees, and administrators.

Attitudes and Directional Concerns.--Pedagogy and/or systems as a technique for improving instruction in the elementary science curricula, novel approaches to the teaching of subject matter context is nothing new. All claims of

"innovativeness" are aided by the concept that techniques and tools themselves assure a novel and more effective kind of instruction. Any type teaching is just as effective where the teacher spends the time so that he inspires the student with sufficient interest and curiosity to make study a pleasure.¹⁴⁶

Ehrie points out the definite need for attitudinal emendation within the classroom from content learning for content sake, to the peddlers of content of courses without consideration of the intent of the course.¹⁴⁷ Ehrie points out the dire need for content relevancy to the need of the learner in the ever developing world due to the increasing knowledge explosion, people explosion, the deterioration of the environment, the persistence of racial and ethnic injustice, and the realities of our dehumanizing technocracy.¹⁴⁸

Norman summarizes Gibson in proclaiming that scientists do not understand the fact that we are in the midst of the information and communication revolution, which will have an impact on science and the way that we

¹⁴⁶Aubrey Gorbman, "Is 'Innovative Teaching' the Same as 'Good Teaching,'" Bio. Science, Vol. 31, No. 17 (September, 1971), pp. 912-913.

¹⁴⁷Elmwood B. Ehrie, "If You Teach the Content, Who Will Teach the Students," The Science Teacher, Vol. 38, No. 6 (September, 1971), pp. 22-24.

¹⁴⁸Ibid.

are conducting it.¹⁴⁹ Norman says scientists still value autonomy, competitiveness and individualism, "being first" and progress. They still see science as an unknown territory and the scientist as a brave explorer.¹⁵⁰

Buke expresses the need of science teachers to point out the human elements of science, and the role that it plays in deciding which directions a culture will and/or should go; because the relevancy of scientific data depends upon the value placed upon it by humans.¹⁵¹

Thinking and Learning.--Bono believes logical thinking has been hailed as the one effective way in which to use the mind, however, when new ideas are thought of, they indicate that they do not necessarily derive as a result of logical thought processes.¹⁵²

Bono explains that vertical thinking has always been the only respectable type of thinking. The smooth progression of vertical thinking from one solid step to another solid step is quite different from lateral thinking.¹⁵³ Bono defines lateral thinking as being:

¹⁴⁹John Norman, "Science and Human Values," The Science Teacher, Vol. 38, No. 7 (October, 1971), p. 11.

¹⁵⁰Ibid.

¹⁵¹Richard H. Buke, "Science Technology and Human Values," Michigan Science Teachers Bulletin, XIX, No. 1 (September-October, 1971), p. 5.

¹⁵²Edward deBono, "The Use of Lateral Thinking" (Ebenezer Baylis and Sons Limited, The Trinity Press, Worcester, and London, 1967), p. 5.

¹⁵³Ibid.

. . . not only concerned with problem solving; it has to do with new ways of looking at things and new ideas of every sort . . . with the best example of lateral thinking the solution does seem logically obvious once it has been revealed. Many people are prepared to explain how it could perfectly well have been reached by vertical thinking. . . . In retrospect the logical sequence from the problem to its solution may be quite easy to see. . . .¹⁵⁴

New ideas are associated with lateral thinking which also seem to be related to creative thinking, creative thinking however, is a special part of lateral thinking which covers a wider field. Bono explains:

Some times the achievement of lateral thinking are genuine creations, at other times, they are nothing more than a new-way of looking at things, and hence somewhat less than full creations . . . the difference between lateral and vertical thinking is that with vertical thinking logic is in control of the mind . . . with lateral thinking logic is at the service of the mind. . . . Lateral thinking is a matter of awareness and practice no revelation.¹⁵⁵

Dewey proclaims that reflective thinking is the better way of thinking. He points out that reflection involves both a sequence of idea and a consequence. These appear he says, in a consecutive ordering in such a way that each determines the next as its proper outcome, while each outcome in turn leans back on or refers to, its predecessor.¹⁵⁶

¹⁵⁴Ibid.

¹⁵⁵John Dewey, How We Think (D.C. Heath and Co., 1933), pp. 3-4.

¹⁵⁶Ibid., p. 6.

Dewey feels that reflective thinking is a chain, and is aimed at a conclusion which in fact impels inquiry.

He says:

Active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further claims to which it tends to constitute reflective thought.¹⁵⁷

Guilford says:

Creative learning aims at a self-starting, resourceful and confident person, ready to face personal, interpersonal and other kinds of problems. Because he is confident, he is also tolerant where there should be tolerance.¹⁵⁸

Guilford further expressed beliefs of creative learning by making the following claims:

A world of tolerant people would be one of peaceful and cooperative people. Thus creativity is the key to education in its fullest senses and to the solution of mankind's, most serious problems.¹⁵⁹

Torrance in his investigation of creative thinking in the early school years found that there was variations in productivity at different grade levels. He found that following declines at the fourth grade level, growth periods occurred at the fifth and sixth grades; he also found that trained students showed a consistent tendency

¹⁵⁷Ibid., p. 9.

¹⁵⁸J. P. Guilford, The Nature of Human Intelligence (New York: McGraw Hill, 1967), p. 8.

¹⁵⁹Ibid.

to become more fluent, flexible, and clever than untrained groups.¹⁶⁰

Reyburn concludes that a fifth grade level student's ability to think divergently can be learned through a planned program of written and oral language over a five-month period.¹⁶¹ In the words of Ghiselin:

the process of change of development of evolution
is the organization of subjective life.¹⁶²

Fligler says:

When a man creates, he manipulates external symbols or objects to produce an unusual event uncommon to himself and/or his environment.¹⁶³

Gagné says discovery learning is not creativity, because discovery can be controlled, and defines both problem solving (discovery) and principle learning and the difference between them as one "the nature and amount of guidance provided by the verbal instructions.

Rogers argues that we need to minimize external evaluation of the learner, as well as his products. For

¹⁶⁰E. P. Torrance "Exploration in Creative Thinking in the Early School Grades" (University of Minnesota, Minneapolis, Bureau of Educational Research, 1959).

¹⁶¹N. J. Reyburn, "Development of Divergent Thinking Thought Oral and Written Language Instruction" (dissertation Abstracts, 1964), 24:5095-5096.

¹⁶²Brewster Ghiselin, "The Creative Process" (Berkeley, California, University of California Press, 1952).

¹⁶³Louis A. Fliegler, "Levels of Creativity," Educational Technology, Vol. 9, No. 21 (April, 1959).

¹⁶⁴Robert M. Gagné, The Conditions of Learning (New York: Holt, Rinehart and Winston, 1965).

Rogers, educational growth emanates from personal growth. To foster individual growth requires an acceptance of the individual as distinct from his role as learner, as well as producer.¹⁶⁵

Washton feels that a more flexible syllabus--free type science program which gives students a high degree of freedom in curriculum, methodology, and interpersonal relations are basic ingredients for promoting creativity in science.¹⁶⁶

One of the most difficult and proportionate demanding desires which appears in any curriculum is the primitive focus on learning. Brehm states that the teacher can no longer afford to do the "telling" but rather provide more first hand experiences.¹⁶⁷ Brehm further emphasizes and suggests:

. . . provision for open ended situations where solutions are not found if one reads far enough in the text. Opportunities to conjecture and to predict on the basis of the best data available. . . . Lecture can be used to augment the experience but not predominate the situation.¹⁶⁸

¹⁶⁵Carl R. Rogers, "Toward a Theory of Creativity," A Source Book for Creative Thinking, ed. by S. J. Parnes (New York: Scribner, 1962).

¹⁶⁶Nathan S. Washtov, "Creativity in Science Teaching," Science Education, Vol. 55, No. 2 (April-June, 1971), pp. 147-150.

¹⁶⁷Shirley A. Brehm, "Earth Science: Where it Fits in the Curriculum," School Science and Mathematics (December, 1972).

¹⁶⁸Ibid.

John Dewey in a reaction against the general nature of the educational process of that day expressed his views thusly:

. . . In short, among the native activities of the young are some that work towards accommodation, assimilation, reproduction, and others that work toward exploration, discovery and creation. Both the weight of adult custom has been thrown upon the retaining and strengthening tendencies toward conformity, and against those which make for variation and dependence.¹⁶⁹

Dewey woefully states that:

. . . The habits of the growing persons are jealously kept within the limit of adult customs. The delightful originality of the child is tamed. Worship of institutions and personages themselves lacking in imaginative foresight, versatile observation and liberal thought is enforced. . . . And yet the intimation never wholly deserts us that there is in the unformed activities of childhood and youth the possibilities of a better life for the community as well as for individuals here and there.¹⁷⁰

Gagné in the listing and explanation of varying learning types asserts that all of these varieties of learning types apply to school instruction.¹⁷¹ The types are listed as follows:

1. Signal learning. The individual learns to make a general, diffuse response to a signal. Likes and dislikes can be acquired through signal learning.
2. Stimulus-response connections. The learner acquires a precise response to a discriminated stimulus. These connections are already possessed by the child when he enters school. These connections are important for further learning.

¹⁶⁹ John Dewey, Human Nature and Conduct (New York: Henry Holt and Co., 1922).

¹⁷⁰ Ibid.

¹⁷¹ Robert M. Gagné, op. cit., pp. 63-64.

3. Chaining. What is required is a chain of two or more stimulus-response connections, an example of this in the elementary grades is printing of letters.
4. Verbal association. The learning of chains that are verbal. Basically, the conditions resemble those for other (motor) chains. Motor chains must be learned at various stages of school learning; (i.e., the acquisition of proficiency in operating and adjusting a scientific instrument).
5. Discrimination. Some of the most important capabilities acquired by young children, who need to learn to distinguish the properties of a great variety of objects and living things, so that they readily tell round from square, blue from green, three from two.
6. Concept learning. The learner acquires a capability of making a common response to a class of stimuli that may differ from each other widely in physical appearance. Concepts may be concrete or defined.
7. Rule learning. A chain of two or more concepts. The operations that the student learns in dealing with objects, numbers, words, and abstract concepts all involve behavior that is rule-governed.
8. Problem solving. The kind of learning that inquires the internal events usually called thinking.¹⁷²

Although these eight types of learning and learning theories are available Gagné further laments that:

The most important class of conditions that distinguishes one form of learning from another is the initial state of the learning . . . in other words, its prerequisites. The condition for chaining for example, requires that the individual have previously learned stimulus-response.¹⁷³

The elementary science program--Science A Process Approach--relies heavily on the psychology of learning

¹⁷²Ibid.

¹⁷³Ibid., p. 65.

theories espoused by Gagné. The subsequent rationale was outlined for that program:

This approach seeks a middle ground between the extremes I have mentioned (the content approach and the creativity view). . . . Specifically, it rejects the 'content approach' idea of learning highly specific facts or principles of any particular science or set of sciences. It substitutes the notion of having children learn generalizable process skills which are behaviorally specific, but which carry the promise of broad transfer-ability across many subject matters. . . . The point of view is that if transferable intellectual processes are to be developed in the child for application to continued learning in science, these intellectual skills must be separately identified, and learned, and otherwise nurtured in a highly systematic manner. It is not enough to be creative 'in general'--one must learn to carry out critical and disciplined thinking in connection with each of the processes of science. One must learn to be thoughtful and inventive about observing, and about predicting, and about manipulating space and time, as well as about generating novel hypotheses.¹⁷⁴

Another prominent psychologist, whose theories were very much involved in the new program Science Curriculum Improvement Study, is Jean Piaget, who attempts to simplify the complicated behavior of a child in a description of how he thinks when his mental activity is stimulated.

Piaget conceives the adaptive interaction between organization and environment to involve two complementary processes:

. . . corresponding to inner organization and outer adaptation, which he calls assimilation and accommodation . . . assimilation occurs whenever an organism utilizes something from the environment

¹⁷⁴Ibid.

and incorporates it . . . accommodation, the process complementary to assimilation, operates as the variations in environmental circumstances demand coping which modifies existing schemata. (Schemata . . . observed repeatable and generalized pieces of behavior.)¹⁷⁵

A much neater sophistication of Piaget's work has been rendered by Shulman who alludes to a third principle as of equal or greater significance as the earlier mentioned principles. Shulman proports the principle of auto-regulation, or equilibration.

Piaget sees the development as a sequence of successive disequilibria followed by adaptations leading to new states of equilibrium. The imbalance can occur because of an ontogenic change occurring naturally as the organism matures. It can also occur in reaction to an input from environment. Since disequilibrium in uncomfortable, the child must accommodate to new situations through active modification of his present cognitive structure.¹⁷⁶

Piaget's theory tends to explain the psychological effects of a child when inconsistency in the child's conceptual background occurs, giving rise to what educators term as being a problem. According to Suchman:

Objects are the easiest elements for the child to recognize. Familiar objects that are clearly visible pose no problems. The chief difficulty is identifying all the objects whether or not they are visible, familiar or seemingly unimportant.¹⁷⁷

¹⁷⁵ Joseph McV. Hunt, Intelligence and Experience (New York: The Ronald Press Co., 1961), pp. 111-112.

¹⁷⁶ Lee S. Shulman, "Psychology and Mathematics Education" (Chicago: The Sixty-Ninth Yearbook of the National Society for the Study of Education, Part I, University of Chicago Press, 1970), ed. by Edward G. Begle, pp. 41-42.

¹⁷⁷ J. Richard Suchman, "Inquiry Training in the Elementary School," The Science Teacher, Vol. 27, No. 7 (November, 1960).

Suchman's method of inquiry development involves the uses of discrepant events to promote the process of inquiry in his inquiry training techniques. He says:

Inquiry training is designed to supplement the ordinary science classroom activities. It gives the child a plan of operation that will help him discover causal factors of physical change through his own initiative and control. . . . The program is aimed at making pupils more independent, systematic, empirical, and inductive in their approach to problems.¹⁷⁸

Fischler, however, brings to mind the importance of recognizing how far removed the discrepant event is from the child's background experience.¹⁷⁹ If he has never had any experience with a particular event, then he does not view the activity as a problem. On the contrary, if in the learning process an event is introduced and we think it to be discrepant and the child does not, and furthermore, can cognitively account for it, then there is no problem to consider. This rationale is basically used for the curricular involving problem-solving techniques. This process, however, only represents one-eighth of the types of learning espoused by Gagné.¹⁸⁰

Some learning cannot be verbalized, and there can be verbalization without understanding. Bruner expresses this very well in pointing out:

¹⁷⁸Ibid.

¹⁷⁹Abraham Fischler, "Implication of Structure for Elementary Science," Science Education, Vol. I, No. 8 (1968), pp. 11-12.

¹⁸⁰Gagné, op. cit., pp. 63-64.

Instruction is, after all, an effort to assist or to shape growth. In devising instruction for the young, one would be ill advised indeed to ignore what is known about growth, its constraints and opportunities. And a theory of instruction, is in effect, a theory of how growth and development are assisted by diverse means. It is appropriate, then, that we begin with the problem of growth and its patterns. The subject is not yet well understood by any means, but it is plain that there is emerging a new consortium of disciplines that one day will constitute 'the growth sciences,' all of those fields concerned with understanding and facilitating the processes whereby human beings go so swiftly from a state of utter helplessness to one of control, what to our forebearers would surely seem like fantastic control, of the environment.¹⁸¹

Is the learner given the opportunity to engage himself in instructional episodes that allow and afford him the opportunity to raise questions and possibly answer some questions meaningful to him as a result of a system designed for him and his life style? If so, then it becomes possible for him to abandon those reinforcements of those behaviors which ignore all personal growth, or learning, and also that which produces little cognitive growth. Bruner "grapples" with what is involved in intellectual growth by setting up some benchmarks about the nature of intellectual growth against which to measure one's efforts at explanation.¹⁸² The list includes the following:

1. Growth is characterized by increasing independence of response from the immediate nature of the stimulus.

¹⁸¹Jerome S. Bruner, Toward a Theory of Instruction (Cambridge, Mass.: 1971), pp. 5-6.

¹⁸²Ibid.

2. Growth depends upon internalizing events into a 'storage system' that corresponds to the environment.
3. Intellectual growth involves an increasing capacity to say to oneself and others, by means of words or symbols, what one has done or what one will do.
4. Intellectual development depends upon a systematic and contingent interaction between a tutor and a learner.
5. Teaching is vastly facilitated by the medium of language, which ends by being not only the medium for exchange but the instrument that the learner can then use himself in bringing order into the environment.
6. Intellectual development is marked by increasing capacity to deal with several alternatives simultaneously, to tend to several sequences during the same period of time, and to allocate time and attention in a manner appropriate to these multiple demands.¹⁸³

If elementary science is used as a vehicle to self knowledge, and less as an unchanging body of knowledge, then it should stress learning in which a learner's entire being is participating. Rogers expresses his concerns in the following manner:

From such remoteness he moves toward an immediacy of experiencing in which he lives openly in his experiencing, and knows that he can turn to it to discover its current meanings. The process involves a loosening of the cognitive maps of experience. From construing experiences in rigid ways, which are perceived as external facts, the client moves toward developing changing, loosely held construing of meaning in experience, constructs which are, modifiable by each new experience.¹⁸⁴

¹⁸³Ibid.

¹⁸⁴Carl Rogers, *On Becoming a Person* (Boston: Houghton Mifflin Co., 1961), p. 63.

Thinking through a personal instructional theory can provide a frame of reference and general direction for teachers in the process of becoming better. Bybee feels that this theory must start with an individual evaluation of self with respect to educational goals and understanding the role of attitudes, beliefs and values as they relate to the teacher's classroom behavior.¹⁸⁵

Summary.--The mode of instruction is not the prevailing factor in the learning process. Good attitudes toward the learner and the learning process coupled with adequate selection of content designed for specific intent with the learner in mind strengthens the probability of learning occurring.

The humanization of the instructional process plays a significant role by providing the type atmosphere needed for fostering good interaction in a learning situation.

While there are many descriptive ways of thinking, one must adopt the process which best fits his mode of behavior for there is no guarantee that a selected thinking and/or learning prescription will be suitable for everyone. Instructors are encouraged to provide as many options as possible for adjusting learners to learning style.

Instructional sequences should provide for individual differences of the learners while refusing to

¹⁸⁵Roger W. Bybee, "You Don't Have to be a Bad Science Teacher to Become a Better Science Teacher" (New Orleans, National Science Teacher Area Convention, November, 1972).

infringe upon the values and attitudes of the learners. The effective teacher realizes that interpersonal relations are not impersonal relations.

Humanism in Elementary Science Curricula

Due to the exhaustion of the use of psychology in existence to effectively create a desirable learning environment, the thirdforce of psychology has been suggested as a possible solution. Bybee and Welch write:

As the era of national curriculum developments wind down, it seems that many new programs are a positive contribution to education in science. The curriculum projects promoted psychomotoric activity as a way for students to gain understanding in the cognitive realm.¹⁸⁶

Bybee and Welch point out the type design used for the curricula projects and says the following:

. . . lessons were designed so that inquiry into problems and involvement with materials would facilitate the discovery of major concepts or processes of science . . . still there is no evidence that science educators have not combined all the factors involved in promoting understanding of science. . . .¹⁸⁷

Behaviorism has played an important part in the conforming and shaping of man's activities. Skinner says:

. . . We can follow the path taken by physics and biology by turning directly to the relation between

¹⁸⁶Rodger W. Bybee and I. David Welch, "The Third Force Humanistic Psychology and Science Education," The Science Teacher, Vol. 39, No. 8 (November, 1972), pp. 18-22.

¹⁸⁷Ibid.

the behavior and the environment and neglecting supposed mediating states of mind.¹⁸⁸

Bruner says:

The strong influence of Darwin on Frued through his works on biological determinism in attempt to explain the aggression, instincts, and drives of man stimulated the following summary of the image of man viewed by Frued.¹⁸⁹

Bruner states:

It remained for Frued to present the image of man as the unfinished product of nature; struggling against unreason, impelled by driving vicissitudes and urges that had to be contained if man were to live in society, host alike the seeds of modesty and majesty, never fully free from an infancy anything but innocent.¹⁹⁰

An orientation in which man can direct himself and his growth is intentionality. Buhler says that is the nature of man to show some intent of purpose and reason to the various stimuli he receives.¹⁹¹ Rollo May confirms this belief by verbalizing: ". . . In leaving out the intent, we leave out the human being. . . ." ¹⁹²

¹⁸⁸B. F. Skinner, Beyond Freedom and Dignity (New York: Alfred A. Knopf, 1971), p. 15.

¹⁸⁹Jerome Bruner, "Frued and the Image of Man," Causes of Behavior: Readings in Child Development and Educational Psychology, ed. by J. F. Rosenblith and W. Allensmith (Boston, Mass.: Allyn and Bacon, Inc., 1962), p. 6.

¹⁹⁰Ibid.

¹⁹¹Charlotte Buhler, "Some Observation on the Psychology of the Third Force," Journal of Humanistic Psychology, Vol. 5 (Spring, 1964), pp. 54-56.

¹⁹²Rollo May, "Will, Decision and Responsibility" (Paper read at a founding conference on Humanistic Psychology at Old Saybrook, Connecticut, 1964).

Bugenthal states:

. . . man intends through having purpose, through valuing, and through creating and recognizing meaning. Man's intentionality is the basis on which he builds his identity and it distinguishes him from other species.¹⁹³

Combs argues that instead of classroom activities effectiveness being judged by the presenter it should in fact be judged by the recipients of the material being presented. Thus, the worthiness of the activity becomes a function of the receptiveness of the recipient. This of course becomes dependent upon the perception of the phenomena.¹⁹⁴ Combs commenting on the perceptual basis of behavior:

. . . All behavior of a person is the direct result of his field of perception at the moment of his behavior.¹⁹⁵

Meaningful eventful activities, which give rise to the stimulation of mental activities as a means of seeking solutions to the eventful activity are discussed by Maslow as follows:

. . . I believe mechanistic science (which in . . . psychology takes the form of behaviorism) to be not

¹⁹³James Bugenthal, "The Challenge that is Man," as cited in Challenges of Humanistic-Psychology, ed. by James Bugenthal (New York: McGraw-Hill Book Co., Inc., 1967).

¹⁹⁴Arthur Combs and David Snygg, Individual Behavior: A Perceptual Approach to Behavior (New York: Harper and Row Publishers, 1959).

¹⁹⁵Arthur Combs, The Professional Education of Teachers: A Perceptual View of Teacher Preparation (Boston, Mass.: Allyn and Bacon, Inc., 1965), p. 12.

incorrect but rather to narrow and limited to serve as a general or comprehensive philosophy. . . .¹⁹⁶

Paul De Hart Hurd states that:

The curriculum has not considered in any direct way the relation of science to the affairs of man, the actualities of life and human condition. . . .¹⁹⁷

Hurd further proclaims:

Science teaching ought to foster emergence of a citizenry that is capable of utilizing science and technology to 'promote the development of man as a human being' . . .¹⁹⁸

Jerome Bruner makes the following statements while answering the question, "What happens now?" (regarding the process of education): Bruner says:

. . . The issues would have to do with how one gives back initiative and a sense of potency, how one activates to tempt one to want to learn again. When that is accomplished then curriculum becomes an issue again--curriculum not as a subject but as an approach to learning and using knowledge.¹⁹⁹

Maslow says:

Generated by this new humanistic philosophy is also a new conception of learning, of teaching, and of education. Stated simply, such a concept holds that function of education . . . the goal so far as human beings are concerned--is ultimately the 'self actualization' of a person, the becoming fully human, the development of the fullest height that the human species can stand up to or that the particular individual can come to. In a less technical way it is

¹⁹⁶ Abraham Maslow, The Psychology of Science: A Reconnaissance (Chicago, Ill.: Henry Regnery Co., 1966), p. 5.

¹⁹⁷ Paul De Hart Hurd, "Scientific Enlightenment for An Age of Science," The Science Teacher, Vol. 37 (January, 1970). p. 13.

¹⁹⁸ Ibid., p. 14.

¹⁹⁹ Jerome Bruner, "The Process of Education Revisited," Phi Delta Kappan, Vol. 51 (September, 1971), p. 20.

helping the person to become the best that he is able to become.²⁰⁰

Brief Summary--Humanism.--To the lower, basic physiological needs such as food, shelter, sex, and sleep higher psychological needs have been added by the humanistic psychologists. These needs are safety, self-esteem and self-actualization. When physiological needs are satisfied, Safety needs occur.

Learners functioning at this level need an environment that is consistent, predictable, secure, and stable. The needs for structure, order and limits at this point becomes apparent at this level of need.

It is obvious that love, affection, belongingness, and inclusion should be encouraged for developing the fullest potential of learners by teachers. Achievement, adequacy, confidence, competence, recognition, attention, appreciation and dignity need to be promoted and fostered, so the esteem for the healthy person is earned.

The humanist feels that a healthy society is composed of healthy individuals.

Pedagogy and Structure Within a Discipline

Nedelsky expresses some very serious concerns about the teaching of science and points out the fact that little effort is made to provide the student with an understanding

²⁰⁰ Abraham H. Maslow, The Farther Reaches of Human Nature (New York: The Viking Press, 1971), pp. 168-169.

of the real world of science. This flaw often leads to science teaching that is highly authoritative, dull and presented with little imagination. Most science courses are "fact" oriented and attempt to stuff students with these facts delineates and short circuits the efforts to provide them with developing the desire to understand science and completely disenchant them with attempts of using the mechanics needed to actually learn. Other concerns important to Nedelsky incorporates the fact that understanding and learning how to learn science are the two abilities that the student is most likely to retain after their course work is completed.²⁰¹ It is further stated by Nedelsky:

The causes of this sad state of affairs are political, economic, social and pedagogic. . . . School teachers do not know much science, and learning science is a slow process; college teachers neither know pedagogy nor are they willing to learn . . . Teaching is partly a science; therefore, valid general actions can be formulated about it and applied to particular situations. But teaching is also an art and thus depends on the motives, tastes, and talents of the teacher.²⁰²

To learn how things are related emanates from the structuring of a subject. This provides understanding in such a way that permits the correlation of many other things to that subject in a meaningful way. The importance

²⁰¹Leo Nedelsky, Science Teaching and Testing (Chicago: Harcourt, Brace and World, Inc., 1965), p. 3.

²⁰²Ibid.

of developing a structuring procedure in the learning process is supported by Bruner when he says:

. . . Perhaps the most basic thing can be said about human memory, after a century of intensive research is that unless detail is placed into a structured pattern, it is rapidly forgotten. . . . An unconnected set of facts has a pitifully short half-life in memory.²⁰³

Curricula developers and teachers should be concerned with the structure of a discipline. Schwab feels that structure is desirable or necessary in the services of three functions.

First, structures permit one to discover what kind of statement one is dealing with and to determine whether it is a verifiably informative statement, a statement designed to move our emotions, a statement of choice, value or decision and so on. Second, structure permits us to determine to what degree and in what sense an informative statement is "true." Third, structure permits us to ascertain more completely or more correctly the meaning of informative statements.²⁰⁴

To fit the need for all students within a science discipline, there is apparent evidence showing that a stable structure provides this type stability.²⁰⁵ Bruner

²⁰³Jerome Bruner, The Process of Education (Cambridge: Harvard University Press, 1961), pp. 7, 24, 31.

²⁰⁴Joseph S. Schwab, "The Structure of the Discipline" (A working paper-project on Instruction of the NEA).

²⁰⁵G. W. Ford and Lawrence Pugno, eds. The Structure of Knowledge and Curriculum (Chicago: Rand McNally and Co., 1964).

suggests however that in order to plan curricula that reflects a basic structure of a field of knowledge one must have a most fundamental understanding of that field of knowledge.²⁰⁶ In stressing the need for the organization of knowledge however, one should initially remember that most of what has been properly called advances in psychological evaluation, has in fact grown from new or better organized knowledge. This can be looked at in a sense/form of traditional skills, sudden inventions, new scientific discoveries, technological improvements or new insights into all problems of knowledges.²⁰⁷

The Rapid Growth in Scientific Knowledge

An understanding of the rapid growth and changing nature of scientific knowledge may help to interpret recent development in science curricula both presently and help to develop capabilities needed to cope with changes of the future.²⁰⁸

Piel in a brief resume of the growth of science from the classical age states:

. . . Until the scientific enterprise began 400 years ago, the rate of invention hugged the time baseline. The stock of technique increased by arithmetic

²⁰⁶Jerome Bruner, The Process of Education (Cambridge: Harvard University Press, 1961), pp. 23-32.

²⁰⁷Julian Huxley, "The Future of Man," Bulletin of The Atomic Scientist, XV (December, 1959), p. 403.

²⁰⁸Gerard Piel, "The Revolution in Man's Labor," Bulletin of the Atomic Scientist, XV (September, 1959), p. 281.

progression as often as not by accident and without real understanding of the principles involved. . . .²⁰⁹

Many reasons have been offered and suggested for justification of the vast and rapidly expanding supply of knowledge possessed by modern man. Many have provided explosive reasons which incorporate some of the following facts. They are, the application of scientific procedures to the whole of human experiences, the invention of instruments, the explosive growth in world population, and the provision of extensive libraries and museums for preserving the accumulated treasures of the past.²¹⁰

Because of the tremendous increase in knowledge it is thought that a new kind of discipline be formed to accommodate and translate the knowledge acquired. This new discipline would produce a new kind of specialist called "relaters." These relaters would devote themselves to the seeking out of effective methods of interrelating the knowledge accumulated for man as an organism.²¹¹ The relater, the pedagogists, the curriculum revisors, all have to deal with the basic problems of determining what is knowable, how it should be structured, and how does it provide for all individuals learning abilities. As of now

²⁰⁹Ibid.

²¹⁰Phillip H. Phenix, "Key Concepts and the Crisis of Learning," Teachers College Record, LVIII (December, 1956), p. 137.

²¹¹T. Keith Glennan, "New Order of Technological Challenge Address," Vital Speeches, XXVI (December 27, 1959).

There is no way in which the information explosion can be effectively dealt with. So many scientists are publishing so much, so madly that the entire world is being drenched with scientific reports. "They keep coming like the sticks carrying water in "The Sorcerer is Apprentice."²¹²

The Field Structure Equals the Subject Structure

Many writers feel that the structure of a field is synonymous in the subject field. There is no argument with the view that learning in a subject field should have a structure which helps relate various integral parts of the learning process and gives increasingly deeper meaning to what otherwise might be an astronomical number of unconnected facts. One would not argue that the structuring of the subject field around a few theoretical formulations or conceptual models is extremely useful for the scholar and researcher, but one would argue that the usefulness of a structure for learning has to do with the ability of students to understand it and to use it as an organizing factor in their learning process.²¹³

Bloom, Hastings and Madaus specifies particular desirable features which illustrate on effective, efficient

²¹²A. R. Patton, Science for the Non-Scientist (Minneapolis, Minnesota: Burgess Publishing Co., 1962), p. 21.

²¹³Benjamin S. Bloom, J. Thomas Hastings, and George F. Madaus, Handbook on Formative and Summative Evaluation of Student Learning (McGraw-Hill Book Co., 1971), p. 12.

discipline by suggesting the following consideration for a structured discipline:

. . . The structure of the learning process should be one in which the student can successfully move from one phase of learning to another. . . . The art of teaching is the analysis of a complex final product into the components which must be attained separately and in some sequence. To teach anything is to have in view the final model to be attained while concentrating on one step at a time in the movement toward the goal. One gets a glimpse of the great power of pedagogy when it is applied to very complex new ideas in mathematics, the science.²¹⁴

In order for this type instruction to occur educational objectives should be designed in specific language and eliminate the use of all of the circular objectives which in fact may not be observed until he is far removed from the immediate school surroundings or full grown.

Bloom, Hastings and Madaus agree that:

. . . When objectives are once defined clearly, they can become models about the utility of statements of educational objectives . . . statements of educational objectives formulated by national curriculum groups or commissions are often very broad in scope for example, 'worthy use of leisure time,' 'the development of good citizenship,' 'to develop an appreciation of the value and power of mathematics in our technological society' . . . perhaps these general statements of purpose would be better labeled 'goals' than objectives. A goal is something broader, longer-range, and more visionary than an objective.²¹⁵

One of the most common and acceptable conceptions of the role of a teacher is that of a giver of information. This image stigmatizes a teacher perhaps because of the historical aspects of teacher behavior and perhaps because most of the

²¹⁴Ibid.

²¹⁵Ibid., p. 21.

instruction on all three levels; (1) elementary, (2) secondary, and (3) higher education, classically has been indicative of this form of instruction.²¹⁶

In support of the established concerns of Gerlach and Ely they suggest as a remedy for the changing teachers role the following:

As new resources for learning become available, the teacher's role tends to change. Most learning sources are designed for individual use which provides new options for instruction. This causes the teacher to rapidly become a director, or facilitator of learning experiences.²¹⁷

If the claim of the necessity of specified objectives and goals helps to eliminate all of the "loose" language in pedagogy then we can more readily accept the comprehensive system of Gerlach and Ely which states ten elements of operation with the system. They are as follows:

1. specification of objectives,
2. selection of content,
3. assessment of entering behaviors,
4. the strategy which will be employed,
5. the organization of students into groups,
6. the allocation of time,
7. the allocation of learning spaces,
8. the selection of appropriate learning resources,
9. the evaluation of teacher and learning performance,
10. an analysis of feedback by the teacher and the learner.²¹⁸

Theory of Instruction.--Before any instructional sequence or structured curricula is designed one must

²¹⁶Vernon S. Gerlach and Donald P. Ely, Teaching and Media A Systematic Approach (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971), p. 9.

²¹⁷Ibid.

²¹⁸Ibid., p. 12.

consider first a theory of instruction. A justification for a theory of instruction is given by Bruner:

. . . psychology already contains theories of learning and of development. But theories of learning and of development are descriptive rather than prescriptive. They tell us what happened after the fact: For example, that most children of six do not yet possess the notion of reversibility. A theory of instruction, on the other hand, might attempt to set forth the best means of leading the child toward the notion of reversibility. A theory of instruction, in short, is concerned with how one wishes to reach can best be learned, with improving rather than describing learning.²¹⁹

It is further pointed out by Bruner that a theory of instruction may be prescriptive in the sense that it sets forth rules concerning the most effective way of achieving knowledge or skills while providing an evaluative mechanism for evaluating any particular way of teaching or learning. A normative theory sets up criteria and states the conditions for meeting them, with the theory exhibiting a high degree of generality.²²⁰

There are four major features that a theory of instruction should exhibit:

1. Should specify the experiences which most effectively implant in the individual a predisposition toward learning--learning in general.
2. Must specify the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner. 'Optional Structure'--a set a proposition from which a larger body of

²¹⁹Jerome Bruner, Toward a Theory of Instruction (Cambridge, Mass.: Belknap Press of Harvard University Press, 1971), p. 40.

²²⁰Ibid.

knowledge can be generated, and it is characteristic that the formulation of such structure depends upon the state of advance of a particular knowledge.

3. Should specify the most effective sequence in which to present to materials to be learned.
4. Should specify the nature of pacing of rewards and punishments in the process of learning and teaching.²²¹

Suchman contends that:

. . . the schools must have a new pedagogy with a new set of goals which subordinates retention to thinking-- Instead of devoting their efforts to storing information and recalling it on demand, they would be developing the cognitive function needed to seek out and organize information in a way that would be most productive of new concepts.²²²

Tyler in a discussion on achievement, testing curriculum construction believes the evaluation and classification of educational objectives must be considered as a part of a total process of curriculum development.²²³ Furthermore, Tyler believes that educational objectives tend to clearly define the ways in which students are expected to be changed by the educative process(es). The final selection of and ordering of the objective necessitates the use of learning theory and philosophy of

²²¹Ibid.

²²²J. Richard Suchman, "Inquiry Training: Building Skills for Autonomous Discovery" (Urbana: College of Education, University of Illinois, June, 1961), p. 6.

²²³Ralph W. Tyler, "Achievement Testing and Curriculum Construction," Trends in Student Personnel Work, ed. by E. G. Williamson (Minneapolis, Minnesota: University of Minnesota Press, 1949), pp. 391-407.

education.²²⁴ Brandwein says that children learn in different ways and at different rates. This creates a need for developing a strategy for teaching children science although the mystery of the learning process escapes us.²²⁵ Brandwein says:

The element of the strategy we propose affect what is to be taught, how, it is to be taught, and when--without an ordering in conceptual schemes the science curriculum becomes a potpourri. . . .²²⁶

Felkin in his writings on Herbart specifies in a section on practical pedagogy that:

. . . Herbart's expressed views were--first examine the theory of instruction, and then, their natures may be perceived more clearly through contrast with each other, consider government and discipline together. 'For the same reason that in psychology presentations were treated or before desire and will, in pedagogy the theory of instruction must precede that of discipline.'²²⁷

Herbart further explains:

. . . Whenever a plan of instruction has to be made for any individual, there will always be found an existent circle of intercourse and experience, in which that individual is placed. This circle is capable of being judiciously widened, on its contents may be more thoroughly examined. . . .²²⁸

²²⁴Ibid.

²²⁵Paul F. Brandwein, "Elements in a Strategy for Teaching Science in the Elementary School," The Teaching of Science (Harvard University Press, 1962), p. 107.

²²⁶Ibid.

²²⁷Henry M. and Emmie Felkin, Herbart's Science and Practice of Education (Boston, D.C. Heath and Co., 1900), p. 81.

²²⁸Ibid., p. 84.

Howe and Ramsey write:

. . . If science were moved from--the elementary curricula, it is difficult to know what would be lost because there is a lack of adequate and appropriate research which examines the actual outcomes of science instruction.²²⁹

The research team of Howe and Ramsey assert that there seems to be no common model among researchers as to what constitutes instruction, which makes it difficult for the authors to bring together representative studies which common generalizations regarding them can be made.²³⁰ They also say:

. . . there was some confusion over terminology used by investigators to describe the instructional procedure and the expected outcomes of the instructional sequence. More basically what is required is a viable instructional theory which can act as a common springboard for research and instruction.²³¹

Howe and Ramsey write in much more detail:

. . . The instructional materials and media available, the characteristics of the pupils to be taught, and the personalities of other traits of the teachers and relatively constant factors in any instructional situation. . . . The two major variables are the possible instructional means and the expected outcome . . . if expected outcomes are defined, they help determine the instructional procedure to be used within the constraints imposed by the characteristics and behaviors of both the teachers and pupils and the instructional materials and media available.²³²

²²⁹Gregor A. Ramsey and Robert W. Howe, "An Analysis of Research: Related to Instructional Procedures in Elementary School Science," Science and Children (April, 1969), pp. 25-35.

²³⁰Ibid., p. 25.

²³¹Ibid.

²³²Ibid., p. 26.

Outside Contributors to Education.--Piaget points out that with so many dedicated educators, exhibiting so much dedication and devotion to the field, rarely does education produce researchers and instructors capable of developing pedagogy into a discipline.²³³ He further points out that most changes in the elementary curricula has been brought about by individuals other than educators. Examples of that claim is illustrated by the following; credit has been given to Comenius to be the first to utilize the nature study approach to science education through his book Orbis Pictus published in 1728. He was trained as a theologian and philosopher. Piaget states that:

Rousseau never held classes, and though he may have had children we know that he did not occupy himself with them to any extent. Froebel, the creator of Kindergartens and the champion of a sensory education (however inadequate it may have been) was a chemist, and a philosopher. Herbart was a psychologist and a philosopher, Mme. Montessori, Decroby, and Clapaiede were all doctors of Medicine, and the latter two psychologists as well. Pestalozzi, on the other hand, perhaps the most illustrious of the pedagogues who were purely and simply educators, invented nothing in the way of new methods or approaches, unless we allow him the use of slate, and even that was simply for reasons of economy.²³⁴

Summary of Pedagogy--Structures.--It would appear that science educators have tended to concentrate more of their efforts on the preparation of teachers of the secondary schools, rather than attempting to identify and define

²³³Jean Piaget, Science of Education and the Psychology of the Child (New York: The Viking Press, 1971), pp. 9-10.

²³⁴Ibid., p. 10.

problems involved in preparing elementary teachers to do a competent job of teaching science.²³⁵ If this situation is to be changed, attention should be given to such problems as:

1. Finding the methods for improving the science competencies of teachers.
2. Developing a vehicle that can be used to effectively teach science in a way in which the needs of the learners can be met.

It is felt that a good curricula sequence must be geared toward an understanding of the learner, including his interests, needs and abilities and their progressive ways through childhood to adolescence. Since there is an informational, populational and knowledge explosion, a new breed of specialists the "relater" (pedagogists) can select and present scientific materials based on an instructional theory making discipline content much more comprehensive to the learner.

Structure then becomes effective in the learning process because it successfully allows the learner to move from one phase of learning to another.

Overview of the Chapter

Discussed in this chapter were topics of the following nature:

²³⁵For a closely related study of this topic see Louis Romano, p. 395 as cited in Audio Visual Materials: Their Nature and Use, edited by Walter Arno Wittich and Charles Francis Schuller (New York: Harper and Brothers, Publishing).

I. Historical trends in elementary science curricula. This segment of the chapter presented contributions of early writers of elementary science curricula and showed that:

1. Group instruction was the primitive focus of the early writers in curricula and stressed the study of things and occurrences.
2. The techniques used for the group discussions were:
 - a. description of objects and picture of objects,
 - b. reading about science--no investigation.
3. Elementary science curricula was predicted on theology although most of its writing involved phenomena.

Also researched and discussed in this chapter were the doctrine and effects of pestalozzianism on the United States along with object teaching and other alternative educational theories. The significance of the "Nature Study" movement was researched and concluded that all enthusiasm for the movement was exhausted by the 1920's and new theorists began to make an impact upon science. The new theorists were discussed in detail as a result of the research in the section "New Directions in Science Education."

The summary of this past history was furnished by an unpublished doctoral dissertation by Staley in which these two important features were revealed in his study:

1. Although many of the teaching practices and underlying philosophies of past elementary school science proceed to impractical or unsound, there were some characteristics of past elementary school science which withstood the advances in social, economical scientific, technological and educational thought and practices. These were the methods, procedures and ideals which characterized much of present elementary school sciences.

2. One of the apparent reasons for the failures of many of the past approaches to the teaching of elementary school science was the teachers lack of understanding of the underlying philosophies and lack of skills needed to implement these programs.

In the section on "Recent Trends In Elementary Science" curricula topics researched and discussed included the birth of the new curricula program, effects of Sputnik, National Science Foundations funded elementary projects, Philosophies and attitudes. In the summary of the "Recent Projects Literature Research Section" there was little evidence found that substantiated the claim that the National Science Foundation funded curricula projects increased the effectiveness of accomplishing a multiplicity of objectives in the general education of students. Moreover, within the same program, there was no evidence that all of the new curricula project students could "apply knowledge to solve daily problems," generate "the ability to communicate

effectively," promote "conceptual thinking," to do "problem solving," "to work together effectively," "to understand and appreciate the way scientist think," "to promote the process of inquiry," "to promote scientific literacy, and other vacuous phrases of the sort.

There was no available research which emphatically concludes that the new curricula developed a significant difference in the ability of pupils to do anything different than to achieve in science over and above any previously used curricula compared to the aforementioned objectives in the previous paragraph.

The literature research questions the claims that the increased use of equipment demanded to effectively implement and support the curricula, did more to increase the frustration level of teachers who termed as "inadequately prepared" or "science shy." The failure of the programs to realize their objectives and purposes suggest that a different vehicle might be more successful if used for elementary science instruction.

With the redesigning of the structure of the federal sources of support for the new programs, the more than 106 centers and 63 universities previously receiving support will suffer severe budget cuts when the axe is lowered. The rationale used for the budget cut; that which proports that the money severed would be used for a more effective and efficient purpose, suggests that the effectiveness of

the overall result of the 106 area centers and the some 63 universities does not warrant the spending of the millions of dollars on the many curricula projects which have been previously supported. The summary of recent projects was followed by a section on attitudes and directional concerns in which topics such as pedagogy and/or systems were discussed as possible vehicles for improving instruction in the elementary science curricula and the need for attitudinal emendation within the classroom to consider the intent of curricula before the use of curricula. In the section on "Thinking and Learning," lateral thinking reflective thinking and logical thinking were focused upon. Creative learning, discovery learning and eight specific type learning as propoerted by Gagné were also discussed as a result of the literature researched. Learning theories were discussed involving the writings of McV. Hunt, Piaget, Shulman, Suchman, Bruner, Rogers, and Fischler. In the section on "Humanism In Elementary Science Curricula" contributions were made by Bybee, Welch, Skinner, Bugenthal, Combs, Snygg, Maslow, and Hurd. The summary for this section stressed the demand to satisfy higher psychological needs such as safty, self esteem and self actualization. The humanist feels that a healthy society is composed of healthy individuals.

The final section "pedagogy and Structure" within a discipline" included arguments from Nedelsky, Bruner,

Schwab, Ford, Pugno, Huxley, Piel and others describing the needs for structure and organization. From the summary of that section it was concluded that if instruction in elementary science is to be changed attention must be given to such problems as:

1. Finding the methods for improving the science competence of teachers.
2. Developing a vehicle that can be used to effectively teach science in a way in which the needs of the learners can be met.

It is felt that any good curricula sequence must be geared toward the understanding of the learner, including his interests, needs and abilities and their progressive ways through childhood to adolescence. It was further determined through this literature research that structure becomes effective in the learning process because it successfully allows the learner to move from one phase of learning to another.

The literature researched for this study suggests that there seems to be a need for a vehicle which will in fact provide the type structure, concern and curricula needed for a more effective outcome in elementary science instruction.

Chapter III will focus upon the description of the study. This description includes comments on the development of the instrument used to collect data, the

data collecting techniques, the design of the study and the general procedures used in the study.

CHAPTER III

DESCRIPTION OF THE STUDY

Purpose of The Study

The purpose of this study was: (1) to develop an embryonic structure for an experimental instructional technique in science whose design and philosophy encourages varied teaching techniques in meeting the need of a participating learner; (2) to identify a positive increase in performance or a fluctuation in performance resulting from the use of this technique, and; (3) to develop an evaluative instrument which will help support the contention that the process is capable of engendering a desirable, predictive outcome for participants.

Design of the Study

The design used for this study was a one group pretest--post-test time series design, which utilized periodic measurement processes on the experimental group and introduced continual treatments on the experimental group into the time series of measurement.¹ The design is diagrammed in the following manner by Campbell and Stanley:

¹Donald J. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research (Chicago: Rand McNally and Co., 1963), p. 37.

$$0_1 \quad 0_2 \quad 0_3 \quad 0_4 \quad X \quad 0_5 \quad 0_6 \quad 0_7 \quad 0_8^2$$

A variation of this design was applied to the study by using a series of treatments to the same participating group over a period of five weeks. This procedure made it possible to measure the increase in behavior changes resulting from the total number of treatments rather than from any particular specified treatment.

Selection of the Sample.--The sample used in this study was from the Buena Vista Township School District, a small township of approximately 10,000 population, whose principal occupation is farming and whose neighboring city's chief occupational background is retailing and manufacturing.

The sample consisted of twenty-one fifth graders and forty-six sixth grade youngsters of the Archer A. Claytor elementary school. The cultural identification of the sample consisted of six Mexican-American participants, one white American participant and sixty black American participants.

Cultural Composition of Township

Buena Vista Township is composed of approximately fifty per cent black Americans; thirty per cent Mexican-Americans and twenty per cent white Americans. Ninety-five per cent of the black and Mexican-American children's parents are factory workers on the middle to lower rung of the

²Ibid.

occupational ladder, while the white American children's parental background is basically farming and blue collar factory work.

Environmental Setting of School and Learners

While the township itself has a high assessed tax base, the physical plant of the Archer A. Claytor Elementary School is located near the lower northeast end of Saginaw, Michigan, where the life style in that section of the township and its neighboring lower central city are indistinguishable. The school is located near three of the Saginaw's central city's schools which receive federal funds for the purpose of improving and upgrading instructional offerings for their learners. These schools are eligible for these monies because the socioeconomic conditions of the community fell within the guidelines of being "deprived" and/or "disadvantaged."

Very much like the project area of the Saginaw City School District, Archer A. Claytor School receives funds for project support of two different kinds as a means of improving its instructional needs. There are many "enrichment" programs being conducted in the Claytor Elementary School, all integrated into the regular academic schedule.

The students of Claytor Elementary Schools, moreover, are industrious, eager, and responsive to favorable activities which offer any type of discrepant event. The

discrepant event, allowing for the actual hands on interaction with phenomena, provides the vehicle needed to satisfy their curiosity about the discrepancy and/or event.

General Procedures

For this experimental instructional curricula or technique, consideration was given to the following areas:

1. The instructional material and media to be used. This consisted of reading materials, workbooks, audio-visual aids, audio-taped materials and laboratory equipment for performing the tasks designed to be used from the workbook.

2. Control variables which constantly "crop" up in the study of academic performances. They are the usual overworked conditions which have been established as "determinants" of pupil characteristics and behaviors. When listed they include I.Q., sex, socioeconomic background, age, grade level, interest, and present level of desired outcome.

3. The style, substance and structure that usually accompanies the individual responsible for the conduction of an instructional sequence. These may be referred to as teacher characteristics, teaching style, interest, philosophy, and special abilities.

Upon inspection of these three sets of characteristics, the investigator recognized the presence of

the number of uncontrollable variables and selected specific variables that could be used to predict academic performance.

The investigator was aware of the fact that if pupil intelligence alone were used to predict academic performances, the correlation methods usually assume that the overall correlation is the same at all levels of intelligence.³

The investigator's concern was not that of a particular intelligence level but rather the acceptance of the participant at any level found within an existing classroom.

With the use of the behavioral objectives constructed in hierarchial form, the investigator attempted to consider only two variables within this instructional sequence.⁴ The first variable was the means of instruction. In this the investigator was concerned with the type of teaching strategy which would be used with the established curricula. This could only be determined after the investigator defined the type of behavior a participant was expected to exhibit upon the completion of the instructional sequence. The second variable was defined as the expected outcome of instruction. Thus the expected behavior was established to be distinguishing and manipulative skills.

³David E. Lavin, The Prediction of Academic Performance (New York: Russel Sage Foundation, 1965), p. 38.

⁴Gregor A. Ramsey and Robert W. Howe, "An Analysis of Research Related to Instructional Procedures in Elementary School Science," Science and Children, Vol. VI, No. 7 (1969), p. 27.

The process by which these behaviors were arrived at was by: (a) team teaching, (b) individualized instruction, (c) programmed instruction, and (d) laboratory-oriented instruction. The media selection included instructional television, video-tape recording, electromagnetic tape recordings, and sixteen millimeter films.

Time Limitation.--One of the requirements for the use of the longitudinal or time series design for research is a stated time limit within the hypotheses. This helps to support causal interpretation; however, it does not establish them with certainty.⁵ The time limitation for this study was a five week period.

The investigator spent an average of four hours a day working with the participants in the study. Sessions usually began at ten o'clock a.m. and lasted until twelve-fifteen p.m. They were resumed at one o'clock p.m. and finished at two-forty p.m.

After formal presentations had been made, extensive practices were provided in small group sessions.

Personnel Involved.--There were five certified teachers including the investigator and three teaching aides, all of whom had in-service training prior to the inception of the investigation.

⁵Lavin, op. cit., p. 49.

The In-Service Training Sessions

An in-service training session was deemed necessary. In the in-service training session, participating team teachers involved in the study were taught to observe the activities of participants using the electromagnetic tapes in order to determine whether a participant was moving at a pace that did not match his ability to perform the in-class activity as prescribed by the script.

If there were not enough time as planned in the script used for the production of the electromagnetic tape, then the tape player was cut off until each participant had completed the task.

Teachers were taught to set up the equipment themselves, to practice each technique that the pupil participants were expected to do and to manipulate the materials prepared for their use. Another facet of the training involved interpersonal interaction with the participants which tended to provide pupil confidence, develop ego and stimulate the desire/drive of the pupil so that he viewed himself as a productive being. Constant, positive reinforcement was stressed in the training session, along with tolerance, understanding, and deemphases on forming value judgments of the participants. The investigator viewed these facets as important in breaking down rigid behavior of teachers who demonstrate power over attitudes to students and who create the drive for peer-group acceptance in students.

Achievement was predicted on drives, emotions, ego and expectations of participants. "The universe is new to most most children which creates challenges for their experiences on all sides, and reacts very impressively on them with phenomena of any magnitude, consequently stimulation tends to create a natural affinity for learning and exploring."⁶

The content material for the study was fixed or kept constant within the study. The fixation of the content material allowed for the manipulation and uses of different instructional strategies within the format, if the participants perform lower than the predicted outcomes. The predictions for this study were 80/80 which means that 80 per cent of the participants will master 80 per cent of the material.

Development of a Curricula and Objectives

The curricula consisted of instructional materials composed of mini-units. Each mini-unit contained less material per mini-unit than found within the entire curricula. This was designed to provide the practice needed to successfully develop the skills of manipulation and distinguishing of participants. This curricula was

⁶Gerald S. Craig, What Research Says to the Teacher (Department of Classroom Teachers, American Educational Research Association of the National Education Association, April, 1957), p. 18 (Washington, D.C.: Am. Ed. Resh. Assoc. April, 1957), p.

basically a two dimensional structure. One dimension was designed to describe what the participants were expected to learn resulting from direct contact with the curricula itself, and the second dimension of the curricula was concerned with the mini-unit organization. These two factors established a dichotomous condition of scope and sequence.

The sequence for this curricula was determined by the intuition of the investigator and the learning advantage that it offered for an elementary school completely devoid of organized science activities presented in a regular sequence.

Behavioral Objectives

The behavioral objectives were used to help facilitate the learning of the materials designed for the participant. Also, they were used to aid the participant in acquiring behavioral patterns written in form of certain human performances. Moreover, they were highlighted by action verbs which were underlined in their curricula to better facilitate ease of comprehension and to help fulfill the expected outcome and prediction of performance of the participant as established by the investigator.

The most significant purpose of the objectives was assessing whether the participant could do the task described for him that he was not able to perform before the instructional episode. This observational or evaluative measurement of the participant's ability was not all

designed to be accomplished by conventional methods. That is, it was not confined to a pencil and paper evaluation but rather was designed to assess cognitive ability by use of non-verbal communication. The investigator sought to measure or assess growth in the affective and psychomotor domain in this investigation.

To determine the feelings and the interest that the participants had for the study, the investigator asked the participants to express these concerns by written communication. The letters were collected and categorized by interest levels. A more detailed analysis of these returns is discussed in the Chapter V.

Hierarchy, Sequence for Growth.--The arrangement of the behavioral objectives in this investigation stressed a step-by-step ordering which established a learning hierarchy. This hierarchy represented an improvement in the cognitive growth of the participants.

The arrangement of behaviors in an order which showed progression helped develop desirable learning hierarchies and provided the basis for the investigator to assess the growth of the participants.⁷ It also provided the basis for successful completion of less difficult tasks before allowing the participants to advance to a more difficult task.

⁷Robert M. Gagné, The Condition of Learning (New York: Holt, Rinehart, and Winston, Inc., 1965), p.

Action Verbs Used in Study.--Action verbs were used in the construction of the behavioral objectives for the Holistic Approach. Those action verbs include a set of definitions which were used to communicate to the investigator, teachers and the assisting teacher aids specific meanings and examples, permitting accurate assessment of the participants' performance.

1. Naming--provide the proper name orally. Example:
 "What are the ends of a bar magnet called?" Response:
 "Poles." "How are the two poles named on a bar magnet?"
 Response: "North and South pole." "Take a cardboard, a
 bar magnet and iron filings. Sprinkle the iron filings on
 the cardboard, tap the cardboard, notice the alignments of
 the iron filings. What is the name given to these lines
 the filings make?" Response: "Lines of forces."

2. Identifying--"By using two bar magnets, place
 the ends close to one another and identify like poles and
 unlike poles by the action of the magnets." (This state-
 ment presupposes the participants have successfully completed
 that activity in their workbooks.) "From the two magnets
 provided, pick up the 'U' shaped magnet." He correctly
 responds because the shape is familiar to him from:
 (a) knowing what a "U" shaped magnet looks like from the
 alphabet, (b) and having watched the telecast which demon-
 strated the types of magnets.

3. Recognizing--"Which of the three magnets are not "U"-shaped or bar-shaped?" The participant picks up the round magnet or points to the round magnet.

4. Distinguishing--The selection of the correct objects or photogram of magnetic fields that are very similar which tends to create frustration for the learner. Example: a magnetic field produced by two sets of bar magnets with different size washers between. The distinguishing factor is the size of the magnetic lines of force between the two sets of magnets. A small washer produces small magnetic lines of force.

5. Describing--"Identify and name the poles of two magnets which interact. Tell how the magnets reacted with similar poles together and then with dissimilar poles together, when the magnets are placed in a stirrup." The participant verbally or orally describes or tells how two strong magnets react as a result of what the participant felt when the two magnets were brought together with similar poles facing each other. The participants then describe the reaction when dissimilar poles are brought together when they are being held only by the thumb and index finger.

6. Ordering--arrange two or more events; set up with a magnetically similar design in proper sequence. Examples: "Arrange these four magnet setups produced by two bar magnets of opposite polarities, each with different size

washers, in order of increasing size of the washer which is placed between the magnets."

Construction of Sequence of the Study

The scope of the curricula was established and depended upon objectives expressed in human behavior performances that were directly noticeable and assessable. The instructional sequence was constructed to show a parallel relation to the scope with behavioral description used as an integral part of the sequence. The scope of the curricula defined the practices carried on in this investigation by stating the action verbs. They were operationally defined as a means of communication with the participants, teachers, teachers aides, and the investigators.

The use of the definitions to further develop the instructional sequence was done by identifying terminal behaviors for that unit of instruction on magnetism.

This terminal behavior articulated very clearly to the participants what the participant was expected to be able to do at the end of the instructional episode. However, as this instructional curricula was developed upon tasks designed in orders of increasing difficulty for which one or more behavior is evident, the participant was expected to have successfully completed a prerequisite for that task. The duration of completing a terminal behavior in this study seems to have differences in

temporal spans (time limitations) for some participants as they were able to accomplish them much sooner than others.

The terminal behaviors were stated in the workbook entitled, "Eye Openers." These terminal behaviors were stated for ease of comprehension by the participant.

The Components and Their Usage Within the Curricula

All curricula for this investigation were written, developed, selected and produced by the investigator and will be discussed in the following sequence.

1. Instructional Television Role

- a. Scripts for Instructional Television
- b. Video tape production
- c. Video tape usage
- d. Teacher and investigator follow-up
- e. Usage of television demonstration activities
- f. The electromagnetic tape

2. "Eye Opener" workbook production

Role of Instructional Television.--Instructional Television was used to prepare video tape recordings for this study to be used as a form of classroom teaching like any other form of instructional media. The use of this facility allowed the investigator to provide stimulation in experimental activities in science by providing provocative questions to the participants in the study. These questions required active participation in an laboratory

experience for possible solutions. The decision to use the television for this study was the outgrowth of the effectiveness of the television to provide every participant with a "front row" seat. The audience viewing demonstrations and physical manipulation on this television can observe more clearly the demonstration process. The electronic capabilities of the television provided much more operational detail of sensitive demonstration than other media. The television was able to enlarge very minute details and smooth out awkward and bulky operations that would otherwise appear poorly done and confusing if presented by a media other than television.

Scripts for Instructional Television.--Before the production of a telelesson, telecast or video-tape recording session, a script was written to be used as an instrument for coordinating the activities of the director, technicians, cameramen, floor manager and the talent. There were two scripts written for this investigation by the investigator, the first entitled "Magnetic Materials" and the second entitled, "Magnetic Fields."

Each television script for this investigation was written to provide: (a) materials for the participants to see, often referred to as "video material," and (b) materials for the participants to hear, often referred to as "audio material."

To facilitate and coordinate the two actions, each script was designed with two columns. Column one was called "video," every thing that the participants were to see was systematically written in this column along with the specific time of projection by the cameraman. Example: In the first telecast two children were pulling on a strong magnet to prove that the magnet had force. This action was listed as "Activity 2--Two children pulling against strong magnet." The audio portion which accompanied this action had "2.--Music." The director used this information to supervise the activities and duties of all persons involved in television production within the television studio. Both television scripts contained all of the key words for superimpositions, key questions for audio taping, explanations of the demonstrations, list of graphics and the appropriate time of projection for the audience viewing. The primary purpose for the script "Magnetic Materials" was to introduce the participants to these concepts:

- (1) magnetism, (2) force, (3) median, (4) midpoint, and
- (5) variables.

Each concept was discussed and explained by use of typed cards, which carried the definitions or demonstrations which modeled the activity. The script limited the loose verbage (usages) that normally take place during traditional classroom instruction.

The time limit for each telecast was one-half hour, and scripts were written accordingly. The key words were highlighted by the process of superimposition.

The process involves the spelling of the words in white plastic letters placed on a "superboard," which is made of wood and covered with a black velvet cloth. The image of the black super board is erased electronically, and only the white letters forming the word appear on the screen. The participants copied this word.

The word remained long enough to allow the slowest writers to get the word. In the classroom during the follow-up, these words are written on the board again for all participants. Definitions were typed on a 3 X 5 card. A kindergarten typewriter was used to produce lettering $\frac{3}{8}$ of an inch high for optimum viewing. All projected definitions were written down by the participants. There were four demonstrations, six supers, two charts, and four typed cards in the script "Magnetic Materials." There were two demonstrations, three supers, one graphic and three magnetic photograms used in the second script "Magnetic fields."

Demonstrations were performed on ITV; however, they often were not carried through to completion. Questions were asked of the participants which required the formulation of an hypothesis suggesting a possible answer. The demonstration served for developing interest in the ITV presentation which did not in fact furnish the final answer

to their problem or question posed. Under the guidance of the teaching "team," they were allowed to deduce the answer for themselves.

Videotape Production.--From the scripts written by the investigator, two video tape recordings were made. The tapes contained all of the integral parts of the curricula necessary for the background experience needed for stimulating participants' individual in-class investigations.

These investigations were aided by use of the "Eye Opener" workbook which contained eight selected activities. These activities were written in successive order of interest and "least difficult" to "most difficult." This insured the investigator that a supportive or subordinate behavior had been reached by the participant, which made it possible to predict whether the next "Eye Opener" could be effectively executed by the participant. This again served as proof that the hierarchy was reasonably and properly arranged.⁸ Gagné purports that failing to achieve a supportive of lower behavior leads to "dropouts" of the learning process at the time the lower behavior is not mastered and that it exhibits doubt as to whether the participant will achieve a behavior designed on a higher level.⁹

⁸Robert M. Gagné, et al., "Factors in Acquiring Knowledge of a Mathematical Task," Psychological Monographs, 76:7(1962), No. 526.

⁹Robert M. Gagné and N. E. Paradise, "Abilities and Learning Sets in Knowledge Acquisition," Psychological Monographs, 75(518):14(1961), No. 518.

Video Tape Usage.--The video tapes produced were taken in the classroom for viewing. The size of the group required a special room for viewing. The school multi-purpose room was decided upon; the seating arrangement and physical structure of the room provided the desired atmosphere for videotape viewing sessions. After the participant viewed the tape, a brief "follow up" and explanation of the individual activities were explained to the participant by the investigator, which provided the background intent needed for individual investigations. The videotapes were available at all times and could be viewed by a single participant or a group of participants upon request. The videotapes were also used during the teacher in-service orientation session.

Teacher Follow-Up.--The effectiveness of ITV is dependent upon strong, supportive teacher follow-up. The follow-up for this study was guided by "Script Excerpts and Comments."

This included two columns; one was entitled "Quotes from ITV--Audio or Action." These quotes were taped on cassettes during the production of the ITV program and included "key questions" designed to stimulate the participants to become involved in laboratory activities. These were all open-ended questions which aroused curiosity. The second column of excerpts was entitled, "Behavior and Duties of Classroom Teachers." This pointed out a systematic

strategy for use which allowed the participants the opportunity to effectively answer the questions.

Uses of Excerpts and Comments from Telecast in the Study

The excerpts and comments from the telecast were used in the study to help the team of teachers initiate in-class activities. The participants needed time to investigate the suggested questions that had been established through the ITV media.

This process diminished the expectation of answers being furnished by the television talent and helped to establish a learning environment for the participants, which provided the basis for the directions of their activities in obtaining the desired answers. Although those elementary teachers assisting felt uncomfortable with individual investigative activities for participants, the investigator furnished the in-class support to those teachers and this engendered total classroom facilitation. This facilitation insured the "hands on" usage of instructional materials provided for the participants of the study. The following descriptions provide a more precise and detailed explanation of the usage of the excerpts and comments from the telecast. Also, the descriptions include the specific quotes copied on audio tape produced from the ITV production.

Script I--Magnetic Materials, Excerpts and CommentsQuotes from T.V. Audio
or ActionBehavior and Duties of the
Classroom Teacher

- | | |
|--|---|
| <p>1. "How many different kinds of objects do you think will be affected by magnets?"</p> | <p>1. A chart of the same type used in TV studio will be in the classroom and replication of this chart on a ditto will be passed out to participants to be used in their discovery method for recording their findings.</p> |
| <p>2. "What do you think will happen if we place this whole magnet into this container of iron washers. (Begin count but don't complete it.)</p> | <p>2. The classroom activity will be used to complete this activity.</p> |
| <p>3. "What do you think will happen if magnets are used to pick up "stuff." On the TV variables are mentioned, demonstrated, and listed. The classroom activity allows for students' perceptual development of variables: sizes of magnets, strengths of magnets, and age of magnets. Elementary components of magnets are discussed as in a class activity but not on ITV.</p> | <p>3. Ample and excessive time should be allowed for experimentation. This allows for holistic development of mental and organic interpersonal responses of learner to equipment and self. The concept of variables should be further discussed by the teacher.</p> |
| <p>4. "How would a moving magnet make other things behave?" This ends with magnetic materials but leads into magnetic fields.</p> | <p>4. The teacher focuses the attention of participants on the classroom activity found in the workbook which allows for many opportunities to experience force-fields. This makes it easier to discuss magnetic fields which is presented in the second television program and to stimulate interest in the area covered by the field and its relative strength.</p> |

Script II--Magnetic Fields, Excerpts and Comments

Quotes from TV and Audio

Behavior and Duties of the Classroom Teacher

- | | |
|---|--|
| <p>1. "Do you know why some materials are magnetic and some are not?" Diagrams of atoms as basic building blocks will be used to develop the concept of indivisible particles carrying "charges."</p> <p>2. "Will the magnets react differently if physically arranged so that this theory can be proved?" This stimulates the demonstration of random arrangements of atoms and then perfect arrangements of atoms. Two Things can be deduced: (1) the arrangement of atoms in an iron bar makes the difference between a magnetized iron bar and a non-magnetized iron bar.</p> <p>3. "If magnets have poles, how do they react; and are they the same?" This leads into polarity (magnetic) and suggests that there might be a difference, but a test must be devised to find out. The children will use magnets and activities designed to investigate these possibilities.</p> <p>4. "How does the space around magnets, where these affects are felt, interest us?" This provokes the concept of magnetic fields and suggests a means of testing their existence.</p> | <p>1. The teacher will have a copy of similar diagrams and will promote discussion in classroom. Through discussion it can be shown that the theory is deduced not "proves." This also leads to the primitive source of the "force" being furnished.</p> <p>2. The teacher will continue to emphasize these facts and repeat the experiment as a possible method to collaborate the fact that in an iron bar magnet the north poles of the atoms are almost all facing in one direction to create the north pole of the magnet, while the south poles of the atoms facing the other direction create the south pole of the magnet.</p> <p>3. Teacher follow-up furnishes the classical two dimensional investigations which show lines of forces, poles, repulsions, attractions, and demonstration of the entire magnetic field. All of these will be participant activities.</p> <p>4. The teacher now stresses the concept fields and demonstrates their existence through prescribed investigations. A graph similar to the one used on the TV will be available, and diagrams of smaller ones will be included in the student's workbook.</p> |
|---|--|

Usage of Activities Stimulated by
Demonstrations Done on Telecast

The four demonstrations in the script "Magnetic Materials" were performed by the participants while being observed by the classroom facilitators. The facilitators had placed at strategic places samples or set-up materials to be used in the process of investigation for completing the demonstration started but not completed on the telecast.

First Activity.--The items included in the first activities were: iron washers, tacks, brads, rubber bands, toothpicks, small nails, horseshoe magnets, bar magnets, and round magnets. The participants were arranged in groups of threes, and a sample of each kind of material was placed in a pile. They inserted the magnets at intervals into the pile of materials and observed what kinds of materials were picked up by the magnet.

Those materials picked up were said to have "responded" to the magnet, and a response was indicated on a chart provided for the participants by a "Y"=yes or a "N"=no in a column provided for responses. Also included was a column for the number of each kind of item responding or sticking to the magnet (see Chart 1 in the Appendix). This process continued until all of the items attracted by the magnets were removed. A count was made each time the magnet was inserted into the pile of materials to determine how many items were removed on each trial. This process continued until all of the items attracted by the magnets

were removed. This activity provided the opportunity to observe the texture and composition of the kinds of items that did not respond to the magnet.

The number of trials needed to remove completely all of the items were counted and used to establish the concept of median. The example of an odd-number set to determine the median was explained, and the example of an even-number set to determine the median was also explained. Both explanations effectively helped them to deduce the fact the median was the mid-point of a given set of numbers. This process developed a method of data collections, and provided observations for the participants. For variations, large pieces of iron and steel, or materials of their derivatives, were provided for further investigations with the magnets.

Second Activity.--The second demonstration presented by the telecast was prescribed for the deduction of the area which exhibited, as a result of the magnet's responses to a large collection of washers, the strongest part of the magnet. The participants placed in a large glass container a large collection of washers. They placed a round magnet into the container and lifted it out slowly and gingerly. They held it in midair for a while and observed the areas of the magnet responding to the washers. They deduced the fact, as a result of observation, that the strength of the magnet was at the end of the magnet; these were later labeled "poles."

Third Activity.--The third demonstration done on ITV was designed to create awareness of differences among the ability of magnets, predicated on sizes, shapes and strengths. These differences in ability were labeled "variables." The different sizes of the same shaped magnets were used. As each size magnet was lowered into a pile of washers in a bowl and pulled out again, the number of washers responding to each magnet were counted and written down in a space provided for on a chart (see Appendix, Chart II). By noticing the differences or variations among the three magnets used, it was deduced that the size of the magnet was a possible variable. The participant also deduced that although the magnets were of different sizes they could possibly have all had the same magnetic strength.

Fourth Activity.--The last demonstration done on the telecast led to an in-class activity designed to show the effect of a moving magnet on a responding substance. The telecast demonstrator used a round magnet and steel balls in a clear plastic container. The magnet was placed beneath the container; and as it moved in a defined direction, the steel balls moved with the magnet.

The activities for the in-class activities of the "Magnetic Materials" may be found in the Appendix under the laboratory workbook sections entitled "Eye Openers" for magnetism.

The second set of activities were designed to provide extensive investigation for the participants in the realm of magnetic theory, magnetic fields, magnet poles and magnetic lines of forces (see "Eye Openers" in Appendix C).

The Electromagnetic Magnetic Tapes

Electromagnetic tapes were produced from electromagnetic scripts. They were designed to reinforce the workbook and also to provide the basic information for participants who exhibit difficulty in reading. The tapes were placed on cassettes, and one tape was used by as few as one or as many as four participants at the same time with head phones connected to a jack box. The jack box was connected to a tape recorder by a wire with a phonograph plug attached to its leads. This allowed for ordinary room participation without disturbance from the tape because only the participant wearing the headphones heard the tape recording. The magnetic tape was carefully planned by use of a script, which denoted variations in time intervals between instruction, depending upon the difficulty of the task being described in the directions (see Appendix D for scripts of electromagnetic tapes).

The "Eye Opener" Laboratory Workbook

This book was written to allow for extensive practice to help the participant internalize and develop the skills that were written for him in terms of human

performances stated in forms of behavioral descriptions. The activities began with the least difficult activity and progressed toward the most difficult activity. There were eight activities. A series of eight eyes were drawn, and one was placed at the beginning of each activity. The size of the eye became larger as a participant moved successfully from one activity to another. Before a subsequent activity could be started, the participant satisfied the prerequisite for that activity. This prerequisite was found under a larger eye which suggested growth of the participant and indicated the beginning of a new sequence of events.

Overview of Content and Objectives of Workbook.--The following materials furnish insight into the content as well as the objectives and sequences of events of the series of activities of the "Eye Opener."

Eye Opener I: the investigation with magnets: The participant is expected to recognize objects which magnets affect and do not affect; to distinguish between the composition of material affected by magnets; to name and classify the two types of materials with which magnets are introduced and to distinguish between the capabilities of magnets. As a prerequisite, the student should have viewed the "Magnetic Materials" telecast.

Eye Opener 2: a fish pond game: The participant is expected to identify, name and distinguish the differences

between magnetic and non-magnetic materials. A material list is provided. The prerequisite for this activity is the successful completion of "Eye Opener 1." Directions of how to proceed are also given.

Eye Opener 3: the walking gym clip: This stresses that the participants recognize what substances are attracted to magnets and describes the action of the gym clip. The prerequisite for this activity is successful completion of "Eye Opener 1 and 2" and viewing the telecast "Magnetic Materials." This activity also includes a materials list and instructions for procedure.

Eye Opener 4: This focuses attention on the concepts of attraction and repulsion. The participant is expected to identify and describe the ends of the magnet which come together and those ends which push away. The prerequisite is the successful completion of "Eye Opener 3." Materials and directions are written.

Eye Opener 5: This is a different version of attraction and repulsion which focused on the emotions and feelings of the participants. The participants describe what they feel when like poles and unlike poles are brought in close proximity to each other. There is no prerequisite, but a materials list and directions are given.

Eye Opener 6: lines of forces: This attempts to establish a mechanism for indirectly detecting a magnetic field by observing the lines of force produced by sprinkling

iron filings over a prescribed apparatus setup. The prerequisite is the successful completion of "Eye Opener 5." A materials list is furnished along with written instructions of operational procedures.

Eye Opener 7: magnetism passes through most substances: This is designed to show the penetrating effects of magnetic fields. The participant is expected to recognize and identify the penetrating ability of magnetism. The prerequisite is successful completion of "Eye Opener 6." A materials list is furnished along with instructional procedures.

Eye Opener 8: photogram of a magnetic field: This is designed to capture a permanent record of the magnetic fields prescribed within the activity. The recognition of the concept of attractions, repulsions and distinctions between types of magnets used to form the fields physically are desired objectives in this activity. This activity also hopes to engender interest in chemistry. The prerequisite for this exercise is the successful completion of "Eye Opener 7." A materials list is given along with specific directions of procedural operations.

The Instrument

The instrument for this study was constructed to insure cultural freedom as it was not predicated on language, thereby no degrees of biasness was created. The instrument was constructed of twenty verbal activities. Fifteen of

them were negatives of magnetic photograms produced chemically by exposing 8 X 10 inch Velox photographic paper to light and developed after iron filing had been sprinkled on it to produce a permanent print of a magnetic field made by arranging and rearranging magnets of different kinds to produce different magnetic fields. Of the remaining five questions, one question, number twenty, was a pictorial arrangement of small diagrams of particles labeled with a "N" and "S" to show randomization and symmetrical alignments of the particles. This diagram helped to identify a non-magnetic substance by the randomly arranged sequence of small particles, and a magnetic substance by the symmetrical size arranged sequence of the small particle. These diagrams of question twenty were constructed according to explanation furnished by the magnetic theory.

The remaining four questions were verbally stated or read to the participant in whatever style the participant wished, making it interpretable by the participant. The instrument was not a standardized instrument of any type; therefore, it was difficult to compare with another instrument for establishing any validity coefficient. It was necessary to determine by an appropriate method whether the evaluation instrument could properly carry out the purposes for which it was designed. By virtue of the fact that the investigation was based on achievement, it was determined that the content of the instrument should

adequately sample the type subject matter for which it was designed. This was done by consulting members of the elementary science staff who were familiar with the subject matter and competent in the field of magnetism.

The decision to use content validity is supported by Sax in his claim that in the evaluation of achievement or performance, the test or evaluation content is of extreme importance.¹⁰

The stated objectives of the participants' workbook were also found to be representative measures of the test item intent. The per-test, post test and observational test used for measurement between the pre-test and post test administration were determined to have high content validity as they were the same instrument. It was decided that the interpretability of the time series design, which is presented in a somewhat antiquated device, he used rather than a shift to a new instrument.¹¹

The developmental hierarchy proved helpful in assessing how far along each participant had moved within the curricula aided by the behavior sequence.

This constant observation in the form of a measurement test helped the investigator to make such determination.

¹⁰ Gilbert Sax, Empirical Foundations of Educational Research (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968), p. 167.

¹¹ Donald J. Campbell and Julian C. Stanley, Experimental and Quasi Experimental Designs for Research (Chicago: Rand McNally and Co., 1963), p. 37.

During the overall investigation period, the participants were asked to suggest hypotheses for the behavior of the magnetic fields. The responses were often checked later by presenting the same test but in a different sequential order of the photograms which, in a sense, served as a minimal revision of the same test. Although the sequential arrangements were altered, the contents of the test were not, so this allowed for the trend or longitudinal assessment by use of the same instrument.

Description of Data Collecting Instruments and Procedures

The data was collected by use of a grid, having one vertical column designated for participants number, and twenty vertical columns moving horizontally, designated for questions one through twenty.

Each individual column, except the participant member, was divided into two sub columns: one was labeled "could"; the second was labeled "could not." At the end of the grid at the farthest most horizontal end, there was space provided for the "raw score" and the "percentage of total responses per participant."

Moving vertically down the column, the two sub columns allow for the determination of correct and incorrect responses and also provide the opportunity for determining an item analysis of each response.

In collecting the data, the investigator or teacher simply observed the participant's performance and placed a check (✓) mark in the column labeled "could" if the participant responded correctly and a (X) in the column labeled "could not" if the participant responded incorrectly. The investigation was conducted on the premises that the participant's response must be totally correct not partially correct. A partially correct response was considered as a totally incorrect response. There also was a final Data Response Sheet which was composed of three 8 X 10 sheets with the following provisions on them. The first sheet provided a particular type action verb used for the post test. This action verb was labeled "Distinguishing." The definition of an action verb provides an acceptable rationale for communicative purposes.

The action verbs: (1) "naming," (2) "identifying," (3) "recognizing," (4) "describing," and (5) "ordering," all possess qualities which necessitate some form of discrimination requiring the utilization of the process of the distinguishing action verb; hence the Final Data Response Sheet was labeled "Distinguishing." The twenty spaces provided were used to write in verbal descriptions of the parallel non-verbal task required of the participants.

The "could" and "could not" column furnished a final growth record to all participants in the study based on the post test performances.

The second sheet contained the actual physical arrangement of the magnets from which the magnetic photograms instruments were made. Each position on the second sheet coincides with the verbal description found on the first sheet. This served as a permanent record of all fifteen tasks required of a participant in the study.

The third sheet contained four written questions plus a pictorial diagram of randomly arranged particles and, also, symmetrically arranged particles which were used to explain magnetized and unmagnetized substances.

The four written tasks could be read by the participants or verbally stated to the participant by the observer.

A high glossed photogram was produced on each configuration. The participant was furnished with a photogram and provided the necessary time equipment with which to work. Samples of this equipment included glass, cardboard, iron filings, wood supports and magnets. This equipment was used by the participant to manipulate the setup until he reproduced on his setup the identical lines of forces seen on the photogram given him.

The observer, upon the completion of the task, then inspected the work and checked the appropriate column provided which read "could" and "could not" do. If participants did not quite understand all of the expectations of them they could question the observer without restriction. However, they were to perform their own task. A final

"Data-response Sheet" was compiled for each participant; and at the end of the study, they were given a sheet representing their performance in the study. During the study, a log was kept consisting of the aforementioned instrument used for collecting the data. The data of each observation was recorded at the time of the observation of each group of participants.

A copy of these three sheets was given to the participants for the participant's own personal record, use and reference. A copy of both instruments can be found in the Appendix.

The Process of Data Collection

The pretest was administered to all participants of the study the first day commencing the study. The instrument used consisted of the fifteen magnetic photographs plus the five additional written and pictorially diagrammed questions.

After the two telecasts and practices sessions from the "Eye Opener" workbook, a series of tests were given at successful intervals using the same instrument. The post test was given after several extensive practice sessions from the "Eye Opener" workbook. Written

material, submitted by those participants who desired to do so, expressed their feelings about the study. The summary of this affective material are presented in Chapter V.

All data collected is recorded in Table of the Appendix. Copies of the written correspondence from participants is also found in the Appendix.

The Analysis of Data

The analysis of the data collected during the experimental study was carried out by the utilization of a number of acceptable statistical treatments. These treatments also clarified and supported many of the hypotheses of the study established in Chapter I. The pre-test and post test scores collected from the participants provided the data to which the statistical techniques were applied. Final scores furnished by the Iowa Test of Basic Skills also were used to statistically test the relationship among variables.

The test analysis of difference between pre- and post test means was used to test hypotheses one, and two. The level of rejection of the null hypothesis was established to be .05.

A correlation technique was used to test hypotheses three, four, five and six. A .05 criteria level was again used to determine significance.

A multivariate ANOVA for repeated measure designs with three individual classes and seven repeated measures

was used to test the achievement on each measure of the classes. To establish a trend of growth, a trend analysis technique was applied.

Reading level skills and language usage skills were used as variables. These variables helped to provide the statistical evidence needed to reject or accept the stated null hypothesis of each variable. For this test these variables were divided into three levels or categories.

The three levels were defined by use of the final scores furnished by the Iowa Test of Basic Skills taken by the participant in March, 1973, for both categories. The range of these measurements was used to define the three levels for both categories. They were classified as Above Average, a range of 42-73; Average, a range of 21-41; and Below Average, a range of 1-20. The levels were coded in the following manner: Above Average was equated to 1; Average was equated to 2; and Below Average was equated to 3. Treatment classes of $C_1 = RL - A$; $C_2 = RL - B$; $C_3 = RL - C$ for reading levels categories and $C_1 = Lu - A$; $C_2 = Lu - B$ while $C_3 = Lu - C$ for the language usage category. The following tables show the representation for the two categories and the number of participants per class.

The three levels Above Average, Average and Below Average were used as independent variables while using the post test scores as dependent variables.

TABLE 1.--Reading levels and treatment classes.

Reading Levels *	Classes			Total
	RL - A	RL - B	RL - C	
Above Average	5	7	3	15
Average	8	8	8	24
Below Average	8	8	12	28
Total	21	23	23	67

* Above Average (top one-third) with numerical rank = 42 - 73. Average (middle one-third) with numerical rank = 21 - 41. Below Average (bottom one-third) with numerical rank = 1 - 20.

TABLE 2.--Language usage and treatment classes.

Language Use *	Classes			Total
	LU - A	LU - B	LU - C	
Above Average	4	2	2	8
Average	7	15	9	31
Below Average	10	6	12	28
Total	21	23	23	67

* The use of a multivariate ANOVA statistical technique was applied to determine the difference between the three reading levels and three language usage levels of the participants in the study.

Summary

This chapter described the general purposes of study and the design used therein. The identification of the sample used for the investigation and their cultural background were also discussed. The general procedures of the investigation provided the descriptive details of the utilization of materials, curricula and techniques during the investigation.

The scope, sequence and behavioral objectives of the study provided the structure needed. The format of the study was strengthened by use of supporting media, such as instructional television, electromagnetic tapes, and motion pictures.

Data collecting techniques and evaluation procedures supplied the data needed for the statistical treatment.

The final phase of this chapter furnished specific details on the methodology used in constructing the categorical groups used for establishing significance along with the restated hypotheses.

The statistical models used for establishing significance were also elaborated upon. In Chapter IV, the results and findings are discussed.

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

Introduction

The contents of this chapter include the restatement of the eleven null hypotheses tested in the study, the analysis of the data collected, and a summary of the findings. Each hypothesis is discussed individually and supportive evidence is contained in tables adjacent to the analysis of the data.

Data Collection and Compilation Procedures

The materials found within this chapter resulted from a study conducted to determine the outcome of a longitudinal and time series design using an experimental teaching method called the holistic approach. This approach and curricula was used to teach culturally different children found within an environment descriptive of an inner city setting to perform distinguishing and manipulating tasks. The data for this study were collected by use of an instrument consisting of 15 individual magnetic photograms and four written questions which were stated verbally to the participants in the language of their environment. The

data-collecting and testing duties were performed by either a teacher-evaluator or the investigator.

The evaluation instrument for this project was designed basically as a nonverbal evaluation instrument. There was no requirement for reading skills or the interpretation of language as required by most standardized instruments used with elementary children in measuring cognitive achievement.

During the time of the study seven measurements were made, five being administered between the pre- and post test.

Use of Pre- and Post-test Data

Pre- and post tests were given in this study, in conjunction with five additional tests, administered between the pre- and post test. These tests were equally spaced in time.

The tests were administered to determine the outcome of continued multiple treatments and frequent testing of one fifth-grade and two sixth-grade classes of the A. A. Claytor Elementary School.

The data collected were statistically treated to test the hypotheses stated for this study. After the treatment of these hypotheses, the findings were compared with the criteria used to establish significance for the hypotheses. This was done to either accept or reject the

hypotheses stated in the null form. The data were also used to provide objective proof that by use of the holistic approach an expected outcome of the participants' behavior could be realized. Other concerns in need of validation were (1) whether the selection of appropriate media would help to effectively execute the teaching strategies selected for the study and (2) whether learners showing different levels of abilities of language usage and reading would be able to execute tasks verbally stated to them determined by use of the instrument developed for the holistic approach.

These concerns could be determined by use of the data collected during the study.

Hypothesis Tested

- HO₁: There will be no mean improvement between the pre- and post test in the participants' ability to perform distinguishing and manipulation tasks as measured by the instrument constructed for the holistic approach.
- HO₂: There will be no mean improvement in achievement per class, between the pre- and post test, and will not represent 80 per cent of the content material being successfully mastered by 80 per cent of the participants, as evidenced by the instrument constructed for the holistic approach.
- HO₃: There is no correlation between the final scores on reading skills, and the final scores on concept skills, as determined by the Iowa Test of Basic Skills.
- HO₄: There is no correlation between the final score on reading skills, and the final scores of problem-solving skills, determined by the Iowa Test of Basic Skills.

- HO₅: There is no correlation between the final scores on language usage skills and concept skills as determined by the Iowa Test of Basic Skills.
- HO₆: There is no correlation between the final scores on language skills and problem-solving skills as determined by the Iowa Test of Basic Skills.
- HO₇: There is no difference between the ability of the three reading level groups to achieve equally as well on a post test measure as determined by the post test scores on the experimental study.
- HO₈: There is no difference between the ability of the three groups of language usage levels to achieve equally as well as measured by the post test scores on the experimental study.
- HO₉: There will be no difference in improvement between the three classes on each measurement M₁---M₇, on the experimental study.
- HO₁₀: There will be no interaction between classes and reading levels on the post test scores of the experimental study.
- HO₁₁: There will be no interaction between classes and language usage levels on the post test scores of the experimental study.

Class Cell Frequency and Cell Means

The class cell frequency for this study was determined by the list of students' names found in the classroom teacher's roll book. The number of names listed in the roll book was counted and added to the sum of the individual names used to determine the frequency for that class. Utilizing the procedure, the frequency (N) for the three classes was determined.

Class number one, a fifth-grade class labeled C_1 , had a frequency of 21 participants. Class number two, the first of the two sixth-grade classes labeled C_2 , had a frequency of 23 participants, and class number three, the second of the two sixth-grade classes labeled C_3 , had a frequency of 23 participants. The cell means in all cases were determined by acceptable statistical methods.

Found within this analysis are various tables which have been formulated to show the results of the statistical treatment of the data collected during the experimental study.

Table 3 shows the means and standard deviations among classes of the experimental study. This data were compared with the means and standard deviation between the

TABLE 3.--Means and standard deviations for three classes on experimental study.

Classes		$\bar{X}$	SD
C_1	21	82.52	5.15
C_2	23	83.75	4.72
C_3	23	82.61	3.62

$C_1 > N=21$; $C_2 > N=23$; $C_3 > N=23$.

language usage groups and the means and standard deviation between the reading level groups. The average means and standard deviation of all three groups were compared to the

total means and standard deviation of the experimental group. This was done to determine the difference between the means and standard deviation of the classes, language level groups and reading level groups. See Table 22 for the results of these comparisons.

Found in Table 4 are the N value, means and standard deviations of the total experimental group.

TABLE 4.--Means and standard deviations for experimental group.

N	$\bar{X}$	SD
67	82.8	4.53

By comparing the means in Table 3 with Table 4, the following discrepancies are evident.

By comparing the means in Table 3 and Table 4, the means of Class C_1 and Class C_3 differ from the means of the total experimental group by .28 for Class C_1 and by .19 for Class C_3 . The means of Class C_2 exceed the means of the total group by .95. The standard deviations of the experimental group exceeds the standard deviation of Class C_3 by a margin of .91, and the standard deviation of C_2 exceeds the standard deviation of the experimental group by a margin of .19. The standard deviation of Class C_1 exceeds the standard deviation of the experimental group by a margin of .62.

Table 5 provides the cell means and standard deviation on seven measures for three classes. The performance of each class is interpreted by use of its cell means.

In Table 5 class C_1 means were greater than Classes C_2 and C_3 on the measurements M_1 --- M_5 . However, there is a marginal difference between the cell means on measures M_7 which can be detected when figures to the right of the decimal point in each cell of each class are compared. While the means of Class C_3 is smaller on measurement M_1 than the means of either Class C_2 or C_3 , a constant improvement is evidenced in Class C_3 through measurement M_6 , then Class C_3 regresses on measurement C_7 .

Table 6 provides the means and standard deviation on pre- and post test scores for seven measures, for the Classes C_1 , C_2 and C_3 . The simplified form of the table provides the clarity needed to detect the discrepancies between the means and standard deviation of the pre-test of the three classes and the increase in the values of the means and standard deviation in the post test measures over time.

Table 7 shows only the pre- and post test measures for the three classes. This table provides the means of the pre- and post test data used in the treatment for a test for significance of the stated null hypothesis (HO_1 and HO_2).

TABLE 5.--Cell means and standard deviation on seven measures for three classes of pre- and post test criteria.*

Classes	M ₁		M ₂		M ₃		M ₄		M ₅		M ₆		M ₇	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
C ₁	2.85	.65	4.80	1.43	8.80	1.99	12.7	1.75	15.7	1.60	17.9	1.02	16.4	1.03
C ₂	2.00	.00	3.82	.576	5.26	.751	8.78	2.50	14.0	2.04	18.4	1.27	16.7	.963
C ₃	.956	.208	4.39	1.37	6.21	2.13	8.60	3.04	12.5	2.46	17.7	1.04	16.5	.730

* C₁>N=21; C₂>N=23; C₃>N=23.

TABLE 6.--Means and standards deviation of pre- and post-measures for three classes on seven measures.*

Classes	Distinguishing and Manipulation			
	Pre-Test		Post Test	
	$\bar{X}$	SD	$\bar{X}$	SD
C ₁	2.85	.65	16.4	1.03
C ₂	2.00	.00	16.7	.93
C ₃	.956	.208	16.5	.730

* C₁>N=21; C₂>N=23; C₃>N=23.

TABLE 7.--Significant difference of pre- and post-means in distinguishing and manipulations on seven measures.*

Classes	Pre-Test	Post Test
	$\bar{X}$	$\bar{X}$
C ₁	2.85	16.4**
C ₂	2.00	16.7**
C ₃	.956	16.5**

* C₁>N=21; C₂>N=23; C₃>N=23.

** Significant at .01 level.

By use of the multivariate analysis technique, the null hypotheses (HO_1 and HO_2) were statistically tested on repeated measures. The univariate, F values, shown in Table 8, along with the probability criteria used for establishing significance was used to reject the null hypotheses (HO_1 and HO_2) at the .05 level.

TABLE 8.--Univariate F values and criteria used from the multivariate analysis comparison for all participants.*

Sources	DF	F Value	P
M_1	--	--	--
M_2	64	16,669.87	.0001**
M_3	64	6,097.85	.0001**
M_4	64	1,952.15	.0001**
M_5	64	393.88	.0001**
M_6	64	83.92	.0001**
M_7	64	105.7473	.0001**

*Gain for Total Group from M_1 --- M_7 when $N=67$.

**Significant at .01 level.

The rejection of the two null hypotheses (HO_1 and HO_2) allows us to accept the alternative hypotheses for (HO_1) and (HO_2). The statistical application used showed

a significant difference between the pre- and post test scores. This statistical treatment also certified the increase in the abilities of the participants of the experimental study to perform manipulation and distinguishing tasks.

Table 9 provides the statistical findings of the results of the data analyzed from the means of all repeated measures. This multivariate analysis technique provided the evidence needed to test the null hypothesis (H_{09}) stating that there would be no difference in improvement between the three classes on each measurement M_1 --- M_7 on the experimental study.

TABLE 9.--Multivariate analysis of different classes on seven measures.

Source	DF	Likelihood Ratio	Chi-Square Approx.	P
Repeated measure	6	.0026	362.40	.0001**
Between classes	14	.0814	153.04	.0001**
Subjects within group	--	--	--	--
Repeated measures by group	12	.2075	96.71	.0001**
<u>Interaction</u>				
RS: Groups*	--	--	--	--

* RS: Groups=Repeated measures by subjects within groups.

** Significant at .01 level.

This statistical evidence provided rejected the null by proving significance at the .05 level. The rejection of the null allows us to accept the fact that there was improvement on each measurement from the pretest M₁ to the post test M₇. It was further shown by this statistical technique that there was interaction among classes.

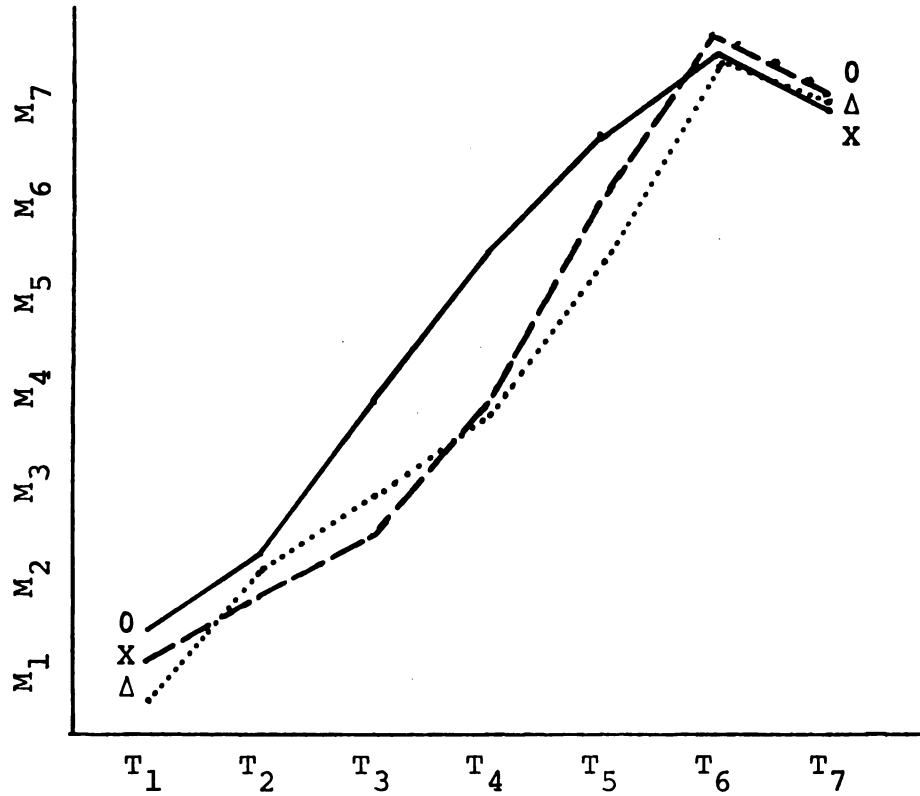
Figure 2 shows the trend of growth for the three groups. The means of cell frequency were used as dependent variables, and the time intervals were used as the independent variables.

Language Usage in the Study

A companion purpose of this study was to determine if the use of language, different from the language found on conventional standardized tests, would increase the participants' ability to perform given tasks more effectively. The study was also interested in whether the language used would create any regression in the ability of the participants to perform the same given tasks.

Four variables were selected from a standardized instrument used to test the basic skills of the participants in March 1973. These variables were reading level skills, language usage skills, concept formation skills and problem-solving skills. Two of these selected variables were categorized into three levels and numerically coded. The levels were "above average," coded (1); "average," coded (2); and "below average," coded (3).

	M_1	M_2	M_3	M_4	M_5	M_6	M_7
C_1	2.85	4.80	8.80	12.7	15.7	17.9	16.4
C_2	2.00	3.82	5.26	8.78	14.0	18.4	16.7
C_3	.956	4.39	6.21	8.60	12.5	17.7	16.5



$C_1 = \begin{vmatrix} 0 \end{vmatrix}$ Class 1
 $C_2 = \begin{vmatrix} X \end{vmatrix}$ Class 2
 $C_3 = \begin{vmatrix} \Delta \end{vmatrix}$ Class 3

Figure 2.--Mean class achievement per observation time.

The frequencies of each cell of the language usage and the reading level groups were established by use of these codes. This helped to investigate whether the levels of categorical grouping affected the ability of the participants to perform the experimental tasks used in the study. These levels were also compared with the variables of concept formation and problem-solving skills of the participants on the same instrument from which the scores were taken.

Table 10 shows the cell means and standard deviations on seven measures of the levels of language usage on pre- and post-test criteria measures.

The achievement of the three levels of language usage is shown by the means per cell on seven measures. The means of the "above average" language usage group are greater than both means of the "average" language usage group and the means of the "below average" language usage group on measure M_1 . The means of the "below average" language usage group are greater than the means of the "average" language usage group on the same measurement M_1 .

The means of the "above average" language usage group are greater than the means of both the "average" language usage group and the "below average" language usage group on measurement M_2 --- M_3 . The means of the "above average" language usage group and the means of the "average" language usage group show very little difference

TABLE 10.--Cell means and standard deviations on seven measures of three* levels of language usage on pre- and post test criteria measures.

Classes	M ₁		M ₂		M ₃		M ₄		M ₅		M ₆		M ₇	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
LU-A	2.25	.886	5.00	.756	7.37	1.68	10.75	2.37	14.8	.991	18.0	.925	17.1	1.35
LU-B	1.80	.883	4.03	1.27	6.45	2.23	10.1	2.68	14.0	1.85	18.1	1.04	16.4	.850
LU-C	1.92	.899	4.46	1.23	6.78	2.45	9.5	3.72	13.8	3.19	17.9	1.31	16.4	.790

* LU-A (Above Average>N=8); LU-B (Average>N=31); LU-C (Below Average>N=28).

throughout the seven measures. The means of all language usage groups are basically equal on the post test measure.

Table 11 shows the cell frequency (N), the means and standard deviations for the total language usage group by levels on the experimental study.

TABLE 11.--Means and standard deviations for language usage group on the experimental study by levels.

	N	$\bar{X}$	SD
Above Average	8	85.56	6.35
Average	31	82.42	4.25
Below Average	28	82.86	3.95

The univariate F values and criteria, established by the use of the multivariate analysis statistical technique applied to the three levels of language usage groups, were the statistical treatment used to determine the significance of the Hypothesis (H_{08}). This hypothesis states that there will be no differences between the achievement among the three levels of language usage groups on the post test measures.

This null hypothesis failed to be rejected at the .05 level. Therefore, this null hypothesis was accepted.

Table 12 provides the statistical treatment for testing that hypothesis. The acceptance of this null

TABLE 12.--Univariate F values and criteria from multivariate analysis of group differences for all participants.

Sources	DF	F Value	P
M ₁	64	.8411	.5607
M ₂	64	2.3316	.1034
M ₃	64	.5550	.5821
M ₄	64	.5722	.5722
M ₅	64	.5754	.5706
M ₆	64	.3073	.7410
M ₇	64	1.7982	.1720*

* No significant difference on post test measure at .05 level. Language group Level difference for Total Group on M₁---M₇ N=67.

hypothesis confirms the claim of the investigator that the achievement on the post test measure was not impeded due to differences in language usage.

Table 13 shows the results of a multivariate analysis of a linear model on seven repeated measures of the three levels of language usage groups. These findings were used to test the null hypothesis (H_{011}). This hypothesis stated that there would be no interaction between the three language group levels and classes on the post test scores. The statistical treatment used for this hypothesis failed to reject the null hypothesis. Therefore, the acceptance of this hypothesis supports the claim that there was no

TABLE 13.--Univariate F values and criteria from multivariate analysis of group interaction for all participants.

Sources	DF	F Value	P
M ₁	--	--	--
M ₂	64	.1247	.8828
M ₃	64	.4187	.6653
M ₄	64	.0706	.9315
M ₅	64	.3907	.6837
M ₆	64	.2189	.8063
M ₇	64	1.9229	.1526*

*No significant differences on post test measure at .05 level. Language group level interaction for total group on M₁---M₇ N=67.

interaction between classes and language usage groups on the post test scores of the experimental study.

While the univariate F values and probability criteria provide basic information on each measure on language usage during the study, additional information may be gleaned from a composite of all seven measurements on language usage.

Table 14 provides the overall results on the language level group over the seven measurements. This information was provided by treating the collected data and applying a multivariate analysis the technique on language usage levels on the seven measures.

TABLE 14.--Multivariate analysis of language usage levels on seven measures.

Source	DF	Likelihood Ratio	Chi-Square Approx.	P
Repeated Measure	6	.0051	321.39	.0001**
Between classes	14	.7744	15.59	.3402
Subjects within group	--	--	--	--
Repeated measures by group	12	.8094	13.00	.3696
<u>Interaction</u>				
RS: Groups*	--	--	--	--

* RS: Groups=Repeated measures by subjects within groups.

** Significant at .01 level.

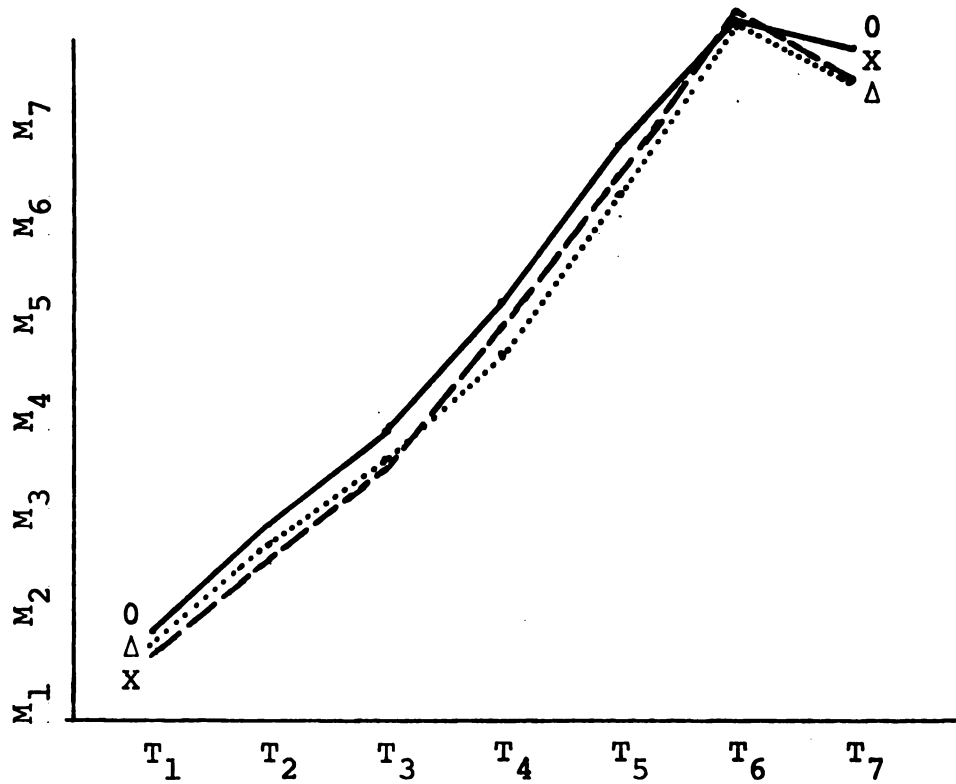
This chart shows that there was a significant difference in the overall language usage groups over the repeated measurement but no significant difference between language level groups. There was no significant interaction of groups by class at the .05 level.

Figure 3 provides a graphical representation of the trend of language usage levels over the seven repeated measures.

Reading Level Effects on the Study

The different levels of language usage groups provided no barriers for the participants' ability to perform

	M_1	M_2	M_3	M_4	M_5	M_6	M_7
LU-A	2.25	5.00	7.37	10.75	14.8	18.0	17.1
LU-B	1.80	4.03	6.45	10.1	14.0	18.1	16.4
LU-C	1.92	4.46	6.78	9.5	13.8	17.9	16.4



LU-A = 0 Above Average
 LU-B = X Average
 LU-C = Δ Below Average

Figure 3.--Mean language usage levels per observation time.

the given tasks of the study effectively. This was supported by the statistical evidence.

To determine the effects of the participant's reading level group upon the execution of tasks, a statistical technique was applied to the corresponding data of desired results.

The cell frequency was determined for each level of reading and constant measurements were made to determine the overall achievement of the participants of all three reading levels.

Table 15 shows the reading level means and standard deviation on seven measures on a pre- and post test criteria.

The reading levels categories demonstrated a similar type trend of growth over the seven measures of the experimental study. There is more uniformity in the means among the reading level groups in this table than was shown in the two tables of the same type on the means of the classes and the means of the language usage levels. However, on the post test, all three groups--i.e., classes, language usage and reading levels--demonstrated equal abilities to perform the given tasks of the experimental study.

Null hypothesis (H_{O_7}) stated that there would be no significant difference between the ability of the three reading level groups to achieve equally on the post test measure. The criteria level for the rejection of this null hypothesis were set at the .05 level. The statistical

TABLE 15.--Cell means and standard deviations on seven measures of three levels of reading on pre- and post test criteria measures.*

Classes	M ₁		M ₂		M ₃		M ₄		M ₅		M ₆		M ₇	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
RL-A	2.13	.743	4.60	.736	7.00	2.42	9.93	3.95	14.6	2.06	18.4	1.05	16.9	1.27
RL-B	1.83	.963	4.00	1.47	6.95	2.23	10.9	2.26	14.4	1.88	17.9	.880	16.2	.737
RL-C	1.85	.722	4.46	1.20	6.32	2.22	9.17	3.43	13.5	2.95	18.03	1.37	16.6	.722

* RL-A (Above Average>N=15); RL-B (Average>N=24); RL-C (Below Average>N=28).

TABLE 16.--Univariate F values and criteria from the multi-variate analysis of reading levels on seven measures.

Sources	DF	F Value	P
M ₁	64	.6384	.5362
M ₂	64	1.3957	.2540
M ₃	64	.6732	.5182
M ₄	64	2.0736	.1321
M ₅	64	1.3766	.2588
M ₆	64	.8452	.5625
M ₇	64	3.0734	.0517*

*No significant difference at the .05 level of post test achievement.

TABLE 17.--Univariate F values and criteria from the multi-variate analysis of reading levels on seven measures for interaction.

Sources	DF	F Value	P
M ₁	--	--	--
M ₂	64	.8262	.5546
M ₃	64	.0363	.9647
M ₄	64	1.3005	.2788
M ₅	64	3.0997	.0504
M ₆	64	1.9046	.1553
M ₇	64	.4375	.6533*

*No significance at the .05 level on post test achievement.

evidence provided showed the null hypothesis failed to be rejected at this criterion level. The verifying acceptance of the hypothesis assumes that there was no difference between these three reading level groups on post test achievement.

For testing the null hypothesis (H_{010}), the multivariate analysis of reading levels on seven measures was used. From the univariate F values and probability criteria, this hypothesis failed to be rejected at the .05 level.

By failing to reject this null hypothesis one accepts the conclusion that there was no interaction between classes and reading levels on the post test scores of the experimental study. While the univariate F value chart was effective in providing the evidence for the acceptance of the null hypothesis, it does not provide any additional information about the reading level groups across seven measurements.

Table 18 gives more insight into the effectiveness of repeated measures across time for accessing the reading level groups.

This chart points out the effectiveness of the repeated measures for the reading level groups by showing significance in reading level over the seven measures. However, this chart shows that there are no differences

TABLE 18.--Multivariate analysis of reading level groups on seven measures.

Source	DF	Likelihood Ratio	Chi-Square Approx.	P
Repeated measure	6	.0039	337.67	.0001**
Between classes	14	.7352	18.76	.1763
Subjects within group	--	--	--	--
Repeated measures by group	12	.8515	9.8860	.6269
RS: Groups	--	--	--	--

** Significant at .01 level.

among the three levels of reading over seven repeated measures, nor was there any interaction over the seven repeated measures.

Table 19 shows the frequency, means and standard deviation of the reading level groups' achievement by levels on the experimental study.

Figure 4 provides a graphical representation of the trend of the three levels of reading across seven measures.

Correlation Data on Specified Variables

This study attempted to determine if there was any relationship existing between given sets of variables. Specific variables were selected for this correlation

TABLE 19.--Means and standard deviation of reading level groups on experimental test.

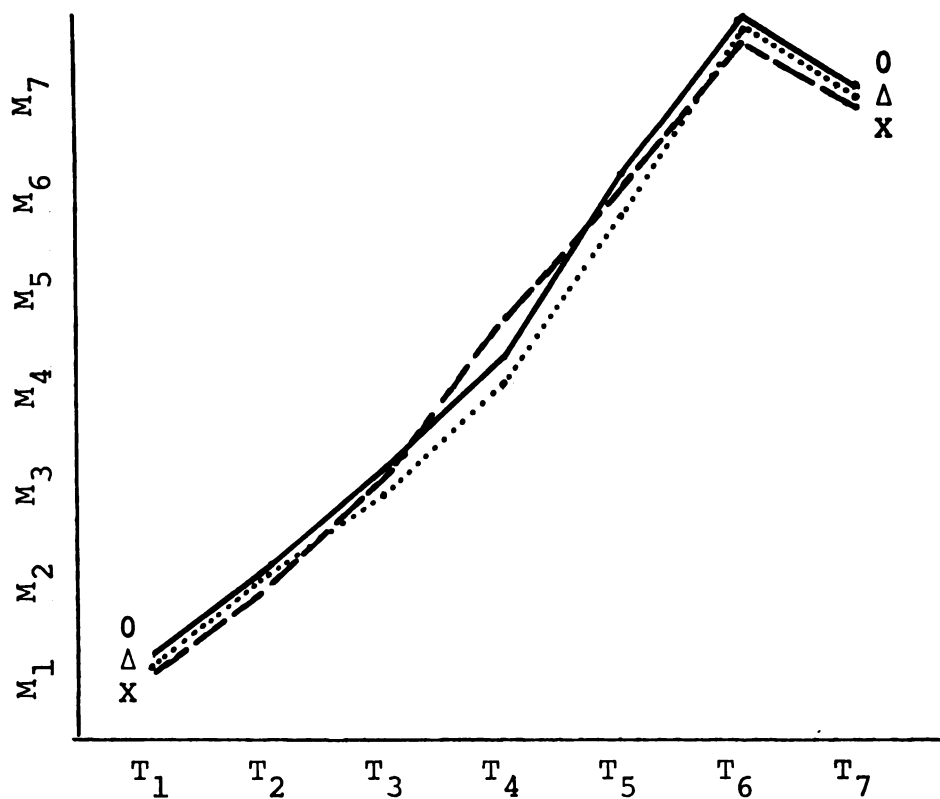
Reading Levels	Manipulations and Distinguishing		
	N	$\bar{X}$	SD
Above Average	15	84.59	6.4
Average	24	81.85	3.96
Below Average	28	83.39	3.61

procedure. These variables were chosen to determine if the language usage skills and the reading skills affected the participants' ability to solve problems and to conceptualize. The scores used for this correlation were standard scores taken from the Iowa Basic Test of Skills. This test was taken by the participants in March 1973.

The correlational variables of interest were reading skills and concept skills, reading skills and problem-solving skills, language usage skills and concept skills, language usage skills and problem-solving skills.

The statistical test r was provided by the use of the Pearson Product Moment Correlation Formula and the application of the analysis of variance statistical technique. These correlations were made to provide the criteria needed for the acceptance or rejection of the null hypothesis (H_{O_3}) between reading skills and concept skills, (H_{O_4}) between reading skills and problem-solving skills, (H_{O_5})

	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇
RL-A	2.13	4.60	7.00	9.93	14.6	18.4	16.9
RL-B	1.83	4.00	6.95	10.9	14.4	17.9	16.2
RL-C	1.85	4.46	6.32	9.17	13.5	18.05	16.6



RL-A = 0 Above Average
 RL-B = X Average
 RL-C = Δ Below Average

Figure 4.--Mean reading level group per observation time.

between language usage skills and concept skills, and (HO_6) between language usage skills and problem-solving skills. The investigator also correlated all of the dependent variables listed as measurements used in the experimental study.

This correlation was done to determine if any two sets of measures showed any degree of correlation between them.

Table 20 shows the results of the correlation of all variables used. There were six from the experimental study and four from the standardized instrument, the Iowa Basic Test of Skills. For this correlation process, only the final scores of the Iowa Basic Test of Skills were used.

In comparing the relationship of the measurements from the experimental study, the means of each of these measurements were used. The correlations were between (M_1 and M_2), (M_2 and M_3), (M_3 and M_4), (M_4 and M_5), (M_5 and M_6) and (M_6 and M_7). This correlational effort was done to provide a different prospective into the trend of the participants' behavior on the experimental study. In all cases of correlations, an attempt was made to detect significant relationship among the 10 variables ($6 + 4$) within statistical acceptance, if they existed.

The significance for the statistical r at the .05 level with 66 degrees of freedom was determined to be .201 for this test. The r value is a two-tail test whose values

TABLE 20.--Analysis of variance Pearson Product moment correlation between post test scores: Between final scores of variables taken from Iowa Basic Test of Skills.

Var.	No.
*	
1	1.00000
2	.31118
3	.42568
4	.82306
5	.60981
6	.53478
7	.35124
8	
9	1.00000
10	.27350 .26535 .51018 1.00000
11	.37130 .47472 1.00000
12	.39960 .44110 .44110 1.00000

* These numbers identify the following variables: (1) pretest measure M₁, (2) measure M₂, (3) measure M₃, (4) measure M₄, (5) measure M₅, (6) measure M₆, (7) measure post test M₇, (8) post test 10 score, (9) concept formation skills, (10) problem-solving skills, (11) reading level skills, (12) language usage skills.

usages correspond to the usage of all F value relationship during the study.

Findings in Table 21

Table 21 provided the necessary findings to establish significance among the variables tested. The null hypothesis (HO_3) stating that there was no correlation between reading skills and concept skills was rejected. The rejection of this hypothesis permitted the acceptance of the alternative hypothesis. The correlation between the two variables was significant with r being .371. The null hypothesis (HO_4) regarding the correlation between reading skills and problem-solving skills was rejected; the rejection of this hypothesis allowed for the acceptance of the alternative hypothesis. The r value between the two variables was shown to be .474. The last two null hypotheses--(HO_5), the correlation between language usage and concept skills, and (HO_6), the correlation between language usage and problem-solving skills--were both rejected. The rejection of these two hypotheses allowed for the acceptance of the two alternative hypotheses, respectively.

The r value between the two variables of (HO_5) was .399. The r value between the two variables of (HO_6) was .365. All four hypotheses were significant at the .05 level. In the separate analysis of the correlation between the means of each successive measures on the experimental study, the following information was apparent and showed significance.

TABLE 21.--Analysis of variance Pearson Product moment correlation between final scores of variables taken from Iowa Basic Test of Skills.

Var. No.

9*	1.00000			
10	.51018	1.00000		
11	.37130	.47472	1.00000	
12	.39960	.36564	.44110	1.00000
	9	10	11	12

*These numbers identify the following variables:
 (9) concept formation skills, (10) problem-solving skills,
 (11) reading level skills, (12) language usage skills.

The r value between the pretest M_1 and test M_2 was .311. The r value between test M_2 and test M_3 was .425. The r value between tests M_3 and M_4 was .823. The r value between test M_4 and test M_5 was .609. The r value between test M_5 and test M_6 was .534. The r value between test M_6 and test M_7 was .351. All r values for the experimental study showed significance. The trend of the r values showed progression from the smallest r value between test M_1 and test M_2 and reached its largest r value at test M_4 . Beginning at test M_4 , the r value between variables began to decrease.

Table 22 shows the post test means and standard deviation of the three classes used in the study. The means and standard deviation for the three classes are also shown by group levels using the variables language usage and reading levels. Both variables were grouped into categories of "above average," "average," and "below average" for comparative purposes to determine whether language usage and reading levels affected the cognitive ability of the participants in the study to achieve significantly, using a nonverbal instrument for evaluation.

This table provides the means and standard deviation needed to conduct additional statistical treatments to uncover any other desired information aside from that reported in this chapter.

The means of the language usage group exceeds the means of the classes by a margin of .66. The means of the

TABLE 22.--Post test means and standard deviation of classes, language usage and reading level.

	Classes			Language Usage			Reading Level	
	$\bar{X}$	SD		$\bar{X}$	SD		$\bar{X}$	SD
C_1	82.52	5.15	AA*	85.56	6.35	AA*	84.57	6.4
C_2	83.72	4.72	A*	82.42	4.25	A*	81.85	3.96
C_3	82.61	3.65	BA*	82.86	3.95	BA*	83.39	3.61
Means $\bar{X}$ = 82.95				$\bar{X}$ = 83.61			$\bar{X}$ = 83.27	

* In all cases, AA = above average; A = average; BA = below average.

reading level group exceeds the means of the classes by a margin of .32.

The means of the total experimental group is 82.8 and the standard deviation is 4.53. The difference between the means of the experimental group and the average means of the three classes is .15. The difference between the means of the experimental group and the average means of the language groups is .03. The difference between the means of the experimental group and the average means of the reading level groups is .47.

Table 23 provides information on the observations made on the three classes, dates of observations, total number of observations per class and class sizes. It also shows the total points accumulated by

TABLE 23.--Observations by class.

		Observations							M	Class Size	P	P	Total Possible
		M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇ **					
Classes C ₁ , C ₂ , C ₃													
Dates													
C ₁	CR	54	101	185	268	331	377	346					
	Dates	4/24/73	5/1/73	5/8/73	5/15/73	5/22/73	5/29/73	6/7/73	7	21	21		420
C ₂	CR	48	92	126	210	270	423	400					
	Dates	4/24/73	5/1/73	5/8/73	5/15/73	5/22/73	5/29/73	6/7/73	7	23	23		460
C ₃	CR	20	101	133	198	288	414	349					
	Dates	4/24/73	5/1/73	5/8/73	5/15/73	5/22/73	5/29/73	6/7/73	7	23	23		460
Total Scores		122	294	444	678	889	1,234	1,095	8	67	67		1,340

* M₁ denotes pretest (M₇***) denotes posttest. M denotes total number of measurement per class.
 PP denotes total number of participant taking all measurements per class; 420, 460, 460, denotes the
 total possible number correct per class per measurement.

the three classes on each measurement. There are two other factors of interest in this table, namely the number of participants who took each test and the total number of possible points per class.

Table 24 summarizes the data analysis for each hypothesis tested. All eleven hypotheses are restated, listing the statistical model used to analyze each hypothesis given and the results of this analysis based upon the .05 criteria level used to test for significance.

The means of the raw data collected in the study were used to construct a trend of academic achievement between the three classes. The use of a time series study assumes a linear progression during an instructional sequence. To decide whether linear progression occurred and to judge the significance of this time series study, a statistical treatment was applied involving the univariate and multivariate analysis of variance, covariance and regression.

This was a trend run for repeated measures. This trend was made to determine if the "holistic approach" showed a linear trend. Table 25 provides the results of this statistical analysis. The criterion used for establishing significance was P is less than .0001. This study proved significant in the first four variables; however, the linear variable is the only variable of importance.

TABLE 24.--Summary of data analysis for each hypothesis tested.

Statement of Hypothesis	Model Used for Analyzing Data	Results Based Upon .05 Level
HO ₁ There will be no mean improvement between the pre- and post-test in the participants' ability to perform distinguishing and manipulation tasks as measured by the instrument constructed for the holistic approach.	Multivariate analysis of linear analysis	A significant difference
HO ₂ There will be no mean improvement in achievement per class between the pre- and post-test and will not represent 80 percent of the content material being successfully mastered by 80 percent of the participants, as evidenced by the instrument constructed for the holistic approach.	Multivariate analysis of linear trend	A significant difference
HO ₃ There is no correlation between the final scores on reading skills and the final scores on concept skills as determined by the <u>Iowa Test of Basic Skills</u> .	Analysis of variance	A significant difference
HO ₄ There is no correlation between the final score on reading skills and the final scores of problem-solving skills determined by the <u>Iowa Test of Basic Skills</u> .	Analysis of variance	A significant difference
HO ₅ There is no correlation between the final scores on language usage skills and concept skills as determined by the <u>Iowa Test of Basic Skills</u> .	Analysis of variance	A significant difference

HO ₆	There is no correlation between the final scores on language skills and problem-solving skills as determined by the <u>Iowa Test of Basic Skills</u> .	Analysis of variance	A significant difference
HO ₇	There is no difference between the ability of the three reading level groups to achieve equally as well on a post-test measure as determined by the post-test scores on the experimental study.	Multivariate analysis of linear trend	No significant difference
HO ₈	There is no difference between the ability of the three groups of language usage levels to achieve equally as well as measured by the post-test scores on the experimental study.	Multivariate analysis of linear trend	No significant difference
HO ₉	There will be no difference in improvement between the three classes on each measurement M ₁ ---M ₇ , on the experimental study.	Multivariate analysis of linear trend	A significant difference
HO ₁₀	There will be no interaction between classes and reading levels on the post-test scores of the experimental study.	Multivariate analysis of linear trend	No significant difference
HO ₁₁	There will be no interaction between classes and language usage levels on the post-test scores of the experimental study.	Multivariate analysis of linear trend	No significant difference

TABLE 25.--F-ratio for multivariate test of equality of mean vector = 4919.63 D.F. = 6. and 59.000 P less than .0001.

Variable	Hypothesis MS	Univariate F	P less Than .0001
1. Linear	9474.53	6053.33	.0001**
2. Quadratic	214.60	61.03	.0001**
3. Cubic Trend	449.77	200.12	.0001**
4. 4 Power	67.9366	74.1390	.0001**
5. 5 Power	3.3831	2.0828	.1539

** Significant at $P < .0001$.

Summary

This chapter utilized the collected data from the study and statistically analyzed it to determine the findings of the hypotheses stated in the commencing segments of the chapter. All hypotheses were individually treated and the findings detailed. Descriptive tables and figures were used to report and record these findings. After all hypotheses were treated, a summary was provided in a table listing and restating the hypotheses, the model used for treatment and the results of treatment.

Of the eleven hypotheses stated, seven proved significant as stated in the null form, and the remaining four hypotheses were positive convictions of the investigator stated in the null form. The failure

to reject these hypotheses proved significant to the investigation.

Found in Chapter V are the conclusions and recommendations for this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

Overview

Found in this chapter is a brief summary of the experimental study specifying the objectives of the study, the experimental curriculum, the design, and hypotheses tested in the study. The findings used to draw conclusions about this study were provided by the data collected and statistically analyzed in Chapter IV.

Implications for future investigators, elementary science teachers and curricula developers are also found within this chapter. The final section of this chapter includes the following discussions:

1. The affects of the experimental study upon the participants used in the study.
2. The recommendations for the implementation of this study and specific areas of the study suitable for future investigation.

Summary

The objectives of this study were:

1. To determine the effects of an experimental teaching strategy called the "Holistic Approach" on fifth and sixth grade learners of culturally different children.

2. To determine the effects of different levels of language usage on the cognitive abilities of learners to perform specific tasks, when stated to them in simple human behavioral terms. Those behavioral terms were stated to them in the language of their environment.

3. To determine if the reading level of a participant of the study affected the participant's ability to perform specific tasks, when stated to them in simple behavioral terms.

4. To determine if the use of a non-verbal instrument for evaluating the achievement of learners could be used with culturally different children. This was done to determine if the participants of this study could achieve at a level of a predicted expected outcome using a specific instructional strategy. The mean achievement on the post test was compared to the mean achievement on the pretest to determine whether the participants in the study would show growth in their abilities to perform distinguishing and manipulating tasks.

These abilities were developed by use of curricula materials written and organized by the investigator.

Scope of the Curricula

The material found within the curricula focused on two specific areas--magnetic materials and magnetic fields.

The first area was concerned with materials that were affected by magnets and with other material whose

properties that were not affected by magnets. The development of reasons for the responses to a magnet were not as important as the description of what occurred when the phenomena were observed.

The second area involved magnetic fields. This concept was selected because it is not easily understood by most learners--especially learners of the fifth and sixth grade level. Extensive work was done in this area with the participants; the materials designed were used to help develop manipulative skills for creating magnetic patterns using iron filing and a series of magnets arranged in various configurations. The patterns thus created were made into photograms. The magnetic photograms were used to develop children's ability to distinguish between different magnetic patterns created by the manipulation of the magnets.

This helped participants develop skills needed to produce lines of forces unaided, and to match them with the lines of forces on the test instrument.

Sequence of the Curricula

The sequence of the curriculum material was as follows:

Television Scripts

Television scripts were written and a video tape recording was made including the kinds of activities to be carried out in class by the participants individually or

in groups. After viewing the video tape a teacher-directed follow-up was conducted. This was always done by the writer explaining the emphasizing the words, definitions, and processes presented by the Video tape. At the close of the follow-up session, the members of the teaching team and their teaching aides helped to assemble apparatus, pass out materials, assign participants to groups and helped students interpret which objectives were to be used for each activity. The teachers also evaluated the children in terms of the lesson objectives of the activities. Initially the curricula writer had developed teacher background materials. Because there was no "scheduled" time for science lessons in the teacher's daily lesson plans prior to the inception of the study, the first attempt to use written materials with the teachers was very ineffective. The decision to verbally instruct the teachers on the order in which each session was to be conducted proved much more productive. This procedure was continued for the duration of the study.

Workbook

Workbooks were written and used in the study for each participant in conjunction with instructional television and video tape materials.

The workbook was used to provide additional activities different from those viewed by participants on television. Activities found in the workbook were written with specific behavioral objectives developed in a hierarchical sequence.

The participant had to complete activities accompanying lower order objectives which provided the prerequisites for objectives of higher order and a more demanding activity. Each objective was related to the materials presented by instructional television in that the activities in the workbook led to the desired outcome of the study. Moreover, after each formal presentation of materials, activities were taken in succession, providing the extensive practice needed to move from one activity to another.

There were eight activities, each having a set of objectives, materials list and operational instruction. For participants who did not wish to read the instructions for each activity in the workbook, audio tapes were provided.

The audio tapes provided the participant another procedural option. He could receive instructions from the facilitator, read the workbook instructions, or listen to the tapes for directions. After each session with participants the teacher was briefed on the strategy for the extensive practice section provided. Practice activities usually occurred later in the day and a transfer activity was provided for the next day.

The following schedule represents the material and the general sequence in which major lessons were presented.

1. Pretest or measurement one.
2. Video tape presentation on magnetic materials and follow-up. Reproduction of follow-up

television demonstrations providing Chart 1 and Chart II for each child.

3. Large group laboratory sessions focusing on "eye-openers" 1-3.
4. Video tape presentation on magnetic fields with follow-up and large laboratory session focusing on "eye openers" four and five.
5. Test on measurement two and "eye opener" six--in class small groups.
6. Measurement three--film: Magnets for Beginners.
7. Measurement four with extensive practice in small groups.
8. Measurement five with extensive practice sessions in small groups--eye opener 8.
9. Measurement six with extensive practice session--eye opener 8.
10. Measurement seven--post test--continued practice.

Summary

The sequencing of the printed and media curricula materials was done in such a way that the instructional television provided the nucleus needed to structure the workbooks, audio tapes, extensive practice sessions, and repeated measurements. These collectively formed the operational synthesis of the Holistic approach. The order was provided by the behavioral objectives of the workbook.

The design used in this study was a quasi-experimental, time series design without a control group.

This design involved a time period of five full weeks of actual instructions and used as series of measurement taken at equal time intervals. Before the first full week of instruction on the study the pretest was administered.

The treatments applied to the participants in the study continued throughout the duration of the study. Measurements were taken at equal intervals between the treatment sessions and the extensive practice sessions. The data collected was treated by the following statistical methods.

1. The analysis of variance.
2. The multivariate analysis of a linear model.
3. A trend analysis.

From the analysis of the means of pre- and post test data and the means of the post test data only, the following results of each null hypotheses became evident when tested at the .01 and the .05 level.

1. There was a significant difference in mean scores between the pre- and post test in the participant's ability to perform distinguishing and manipulating tasks as measured by the instrument constructed for the Holistic Approach.

2. There was a significant difference in mean improvement in achievement per class, between the pre- and post test, and did represent 80 per cent of the content material being successfully mastered by 80 per cent of the participants, as evidenced by the instrument constructed for the Holistic Approach.

3. There was a significant difference in correlation between the final scores on reading skills, and the final scores on concept skills as determined by the Iowa Test of Basic Skills.

4. There was a significant difference in correlation between the final scores on reading skills, and the final scores on problem solving skills as determined by the Iowa Test of Basic Skills.

5. There was a significant difference in correlation between the final scores on language usage skills and concept skills as determined by the Iowa Test of Basic Skills.

6. There was a significant difference in correlation between the final scores on language skills and problem-solving skills as determined by the Iowa Test of Basic Skills.

7. There was no significant difference between the abilities of the three reading level groups to achieve equally as well on a post test measure as determined by the post test scores on the experimental study.

8. There was no significant difference between the ability of the three groups of language usage levels to achieve equally as well on distinguishing and manipulation as measured by the post test scores on the experimental study.

9. There was a significant difference in the amount of improvement between the three classes on each measurement M_1 --- M_7 , on the experimental study.

10. There was no interaction between classes and reading levels on the post test scores of the experimental study.

11. There was no interaction between classes and language usage levels on the post test score of the experimental study.

Conclusions

The conclusions for this study are predicted on the findings of this study. The descriptions of the conclusions found below seems justified.

1. The significant findings and the rejection of null hypotheses (HO_1) one and (HO_2) two suggests that the strategies used for the Holistic Approach differed from techniques and philosophies used in conventional strategies.

The difference in use of strategies provided in this study offered the participants of the study, procedural options of selecting and utilizing the strategies which were suitable for their learning styles.

Furthermore, the statistical proof of the abilities of the participants to execute tasks better after this instructional sequence had been applied provides the evidence that the cognitive abilities of culturally different children were enhanced and improved when given direct and specific verbal instructions in the language of their environment.

2. The significant proof of the statistical correlational treatment of hypothesis (HO_3) three, (HO_4) four, (HO_5) five and (HO_6) six, between reading levels, language usage, concept formation and problem-solving on the standardized test, provided conclusive evidence that the participants of the study possessed ability to conceptualize and solve problems. These abilities were validated by the experimental study. This validation was made possible by providing physical interaction with simulated representation of a phenomenological condition of magnetism. This further suggests that continuous interactions with material substances can be used to explain behaviors of theoretical entities by extensive practice and appropriate materials.

3. The acceptance of the null hypotheses (HO_7), and (HO_8) proved that there was no difference between abilities of reading level groups (HO_7), and language usage level groups HO_8 , to achieve on the post test. This allowed the investigator to conclude that efforts to adjust to the environmental conditions were successful and the precision of diction did not hinder the quest for knowledge.

4. The rejection of the null hypothesis (HO_9) which indicated that there was a difference between the two classes suggest that the differences could be attributed to variables such as the stratification of the large group, age levels, maturation, interest, sex, and the time of year the study was conducted.

5. The acceptance of the hypotheses (HO_{10}), and (HO_{11}) which espoused that there would be no interaction between classes and reading levels (HO_{10}), and no interaction between classes and language usage (HO_{11}) suggest that the significant differences between the three classes was not due to language usage and reading level grouping. It also implies that the differences between the three classes' post test score are attributable to some other variable(s).

Implications from the Study

1. The participants demonstrated that the use of "standard" language and English did not offer any barriers to the abilities of the participants to achieve and satisfied the environmental language requirement of culturally different children.

This implies that achievement in this study was due to the interest, interpretation and the articulation generated by the action verbs written in terms of simply human performance for the participants. Moreover, the accomplishment of the objectives using action verbs proved effective and suggests that the participants did not have to "figure out" what was expected of them. Consequently the findings of this study suggest that students would benefit greatly from being told precisely what is expected of them and, when told what to do, they can do it.

2. The utilization of a non-verbal instrument for evaluation proved effective in this study. The participants showed favorable responses to an evaluation technique of this type. The challenges that it offered seemingly stimulated their mental activities as they were able to successfully test and verify their hypothesis.

It appears that an instrumentation of evaluation that offered novelty promoted eagerness to learn. The utilization of additional instruments of this type in the future should prove challenging and exciting to most learners.

3. The analysis of the data collected statistically showed that by specifying a desirable type behavior, predicting an expected academic performance and using a variety of instructional strategies and accompanying media, participants performed favorable. This suggests that in the attempt to engender a desired academic standard, teachers and researchers should identify and use only those variables that they can control.

4. The strategies, philosophy, and content specifications of the "Holistic Approach" suggest that participants subjected to this experimental strategy and curricula achieved significantly. It appears that the usage of other programs of this design might prove effective in the learning process.

The Effects of the Experimental Study on Participants

The investigator was interested in the affective domain of the participants. To determine how the participants felt about the program organically, the participants were asked to write letters to the investigators expressing their feelings for the experimental study. From the letters returned, three words were used to express their feelings for the program in all written communication. They were "enjoyed very much," "enjoyed," and "liked." These three words were used to establish categorical groupings of all returns from the participants.

The following information expresses the status of the returns in terms of percentages, calculated from the total number of written returns received from the participants. Sixty-seven per cent of the returns stated that they "enjoyed it very much," twenty-two percent said they "enjoyed it," and eleven per cent exclaimed they "liked it." These expressions of feelings for the program, coupled with the achievement of the participants in the program suggests that the affective domain of the participants was enhanced along with the cognitive domain and the psychomotor domain. This further suggests that the "Holistic Approach" was successful as an instructional strategy.

Recommendations

Based upon the findings of the experimental study, the following recommendations seem appropriate.

It is recommended that more longitudinal and time series studies be done. This type of study provides continual measurement and does not focus on achievement at only one given time.

It is recommended that the use of behavioral objectives and action verbs become more evident in instructional sequences. This supplies the student with the information needed telling him exactly what is expected of him when achievement is the expected outcome.

It is recommended that elementary class activities, investigations and curricula specification include the use of multi-media, multi-material and novel approaches to instruction. These provisions tend to engender the desire of a student to actively participate in an instructional sequence such as the experimental study.

It is further recommended that further research be done to implement this study focusing specifically on determining (a) why the differences occurred between classes, (b) in which class the difference is found and (c) how does it differ.

It is recommended that non-verbal evaluation materials be used for implementing conventional evaluation techniques and also be considered for use on all levels of instruction.

It is recommended that more novel consideration be given to the use of "standard" materials, curricula and strategies with culturally different groups until such time that all cultural groups have had access to most of the background experiences needed to cope in society. This is especially essential in a society such as ours which assumes that all things are available to all members of that society.

It is recommended that only variables that are controllable by the investigator, teacher and curricula developers are considered when an instructional sequence is designed.

It is recommended that investigative studies and classroom instructional processes encourage verbal or written feedback from learners on their actual feelings about the instructional strategy being used for their elementary science studies. Such suggestions to an investigator or instructor provides helpful insight into the facilitation of strategies suitable for most learning styles during an instructional sequence.

It is recommended that inservice preparation training be furnished to teachers required to work with culturally different groups.

It is recommended that inservice preparation and/or training be furnished to elementary science teachers

required and/or electing to work with culturally different groups. This training should stress the application of novel approaches to existing required academic endeavors, utilizing as much conventional hardware and software as possible/available.

It is recommended that a central figure or leader be used in a total design of the specific instrumentation of a curricula. This leader should have working knowledge of the instrumentation used in design and should be able to impart this knowledge to assisting team members.

The curricula itself should be multi-phasic and all available material used should involve physical interaction with the materials by the participating team members prior to pupil useage. The promotion of work and activities to each team member should depend upon strength and weaknesses of the supporting team assuming that the capabilities of team members will vary. Constant inservice training should be provided by the leader, for the assisting teaching team. The success of this instructional design will depend upon the planning and sensitivity of the central leader and cooperative efforts of the supporting team.

It is recommended that federal and state funding be provided to implement this approach at the national level. The funds furnished would be used to employ the services of consultants, purchase special equipment,

conduct in-service training and provide mini-work shops for both central leaders and supportive team members.

It is recommended that special materials be furnished for culturally different groups to help develop the "coping" ability to handle already existing conventional materials. This material would serve as a "human-physical mechanical transformer" allowing culturally different groups to move at a rate suitable to their ability. This "human mechanical transformer" could relate the functions of the conventional material by benefiting from observing the step down activities of the transformer.

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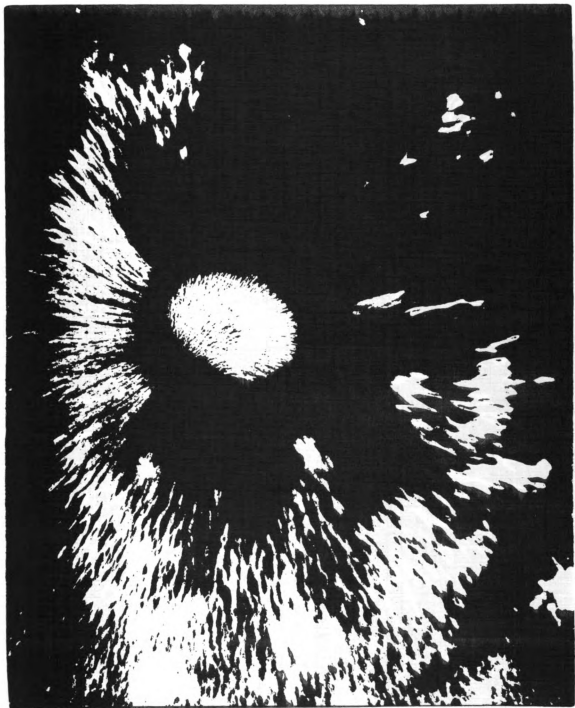
Year Books

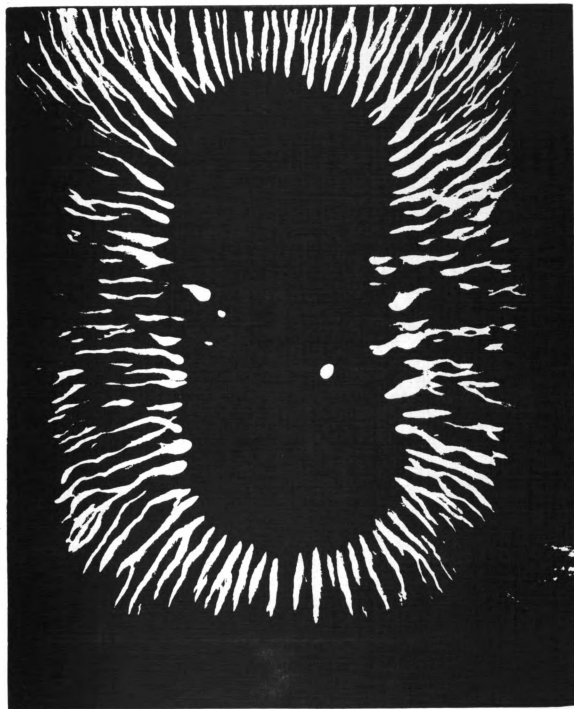
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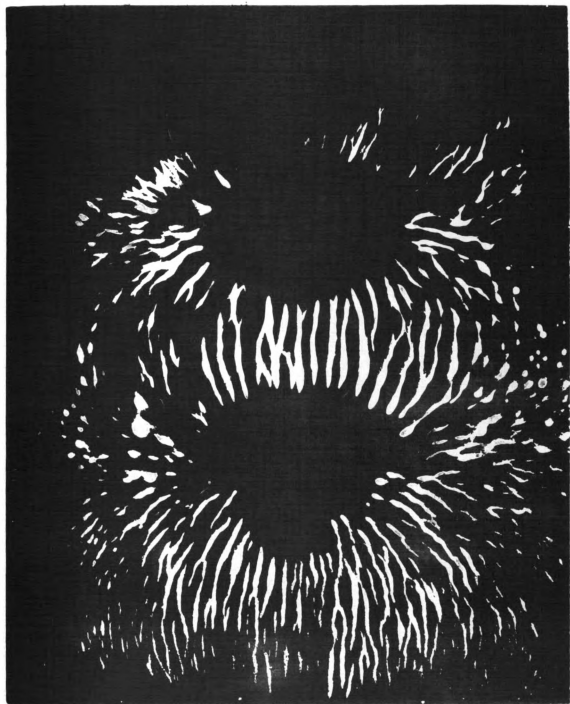
APPENDICES

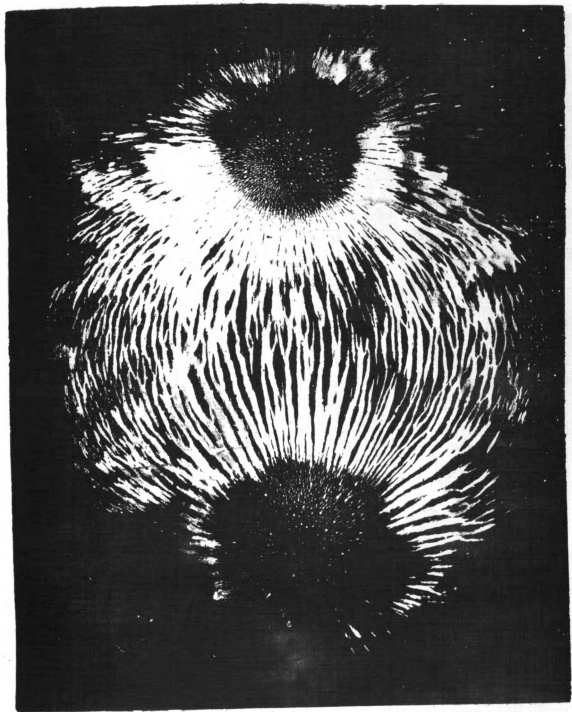
APPENDIX A

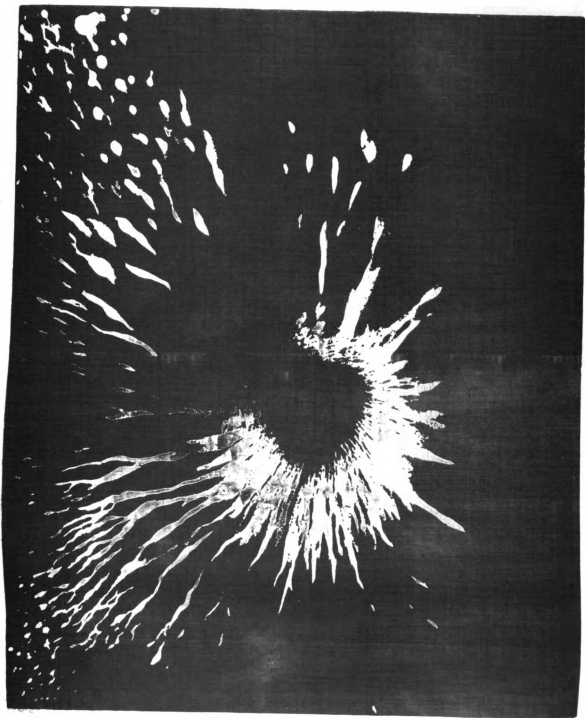
FIFTEEN MAGNETIC PHOTOGRAMS

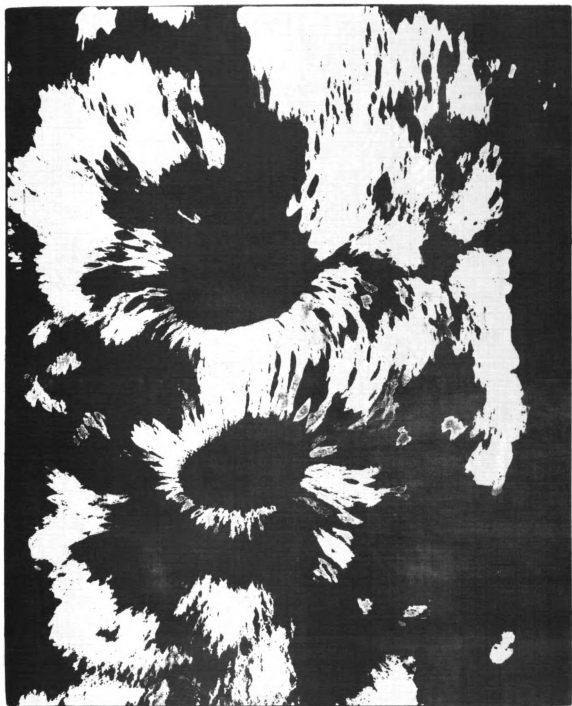


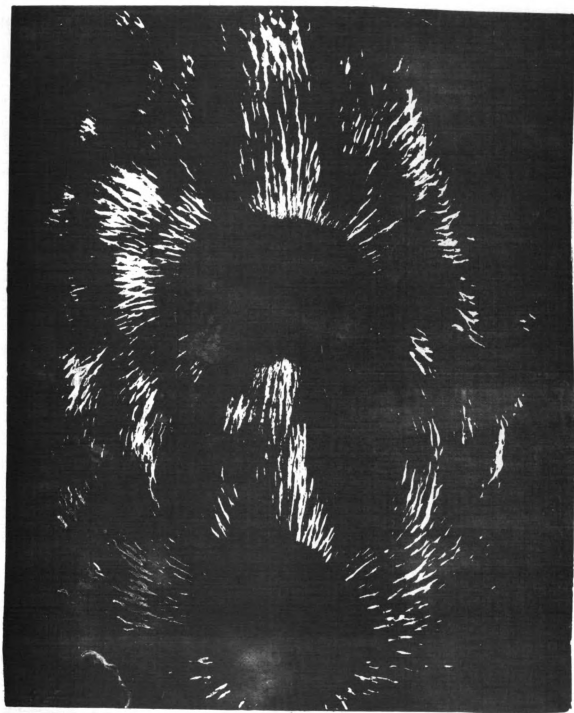




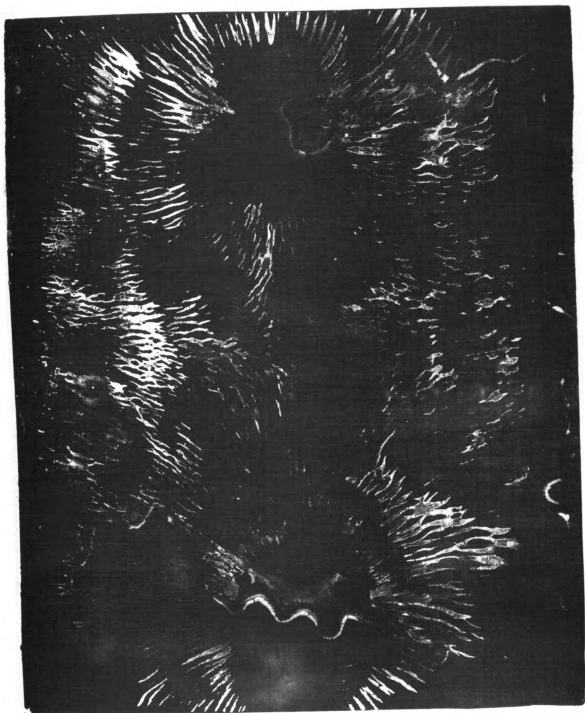




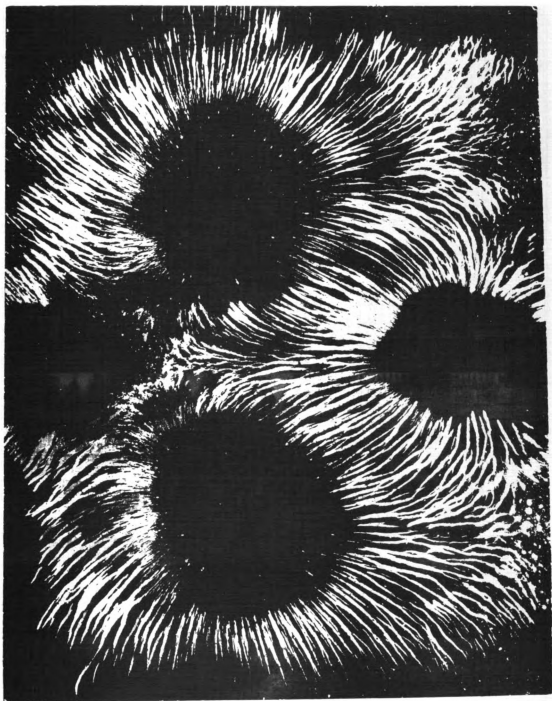






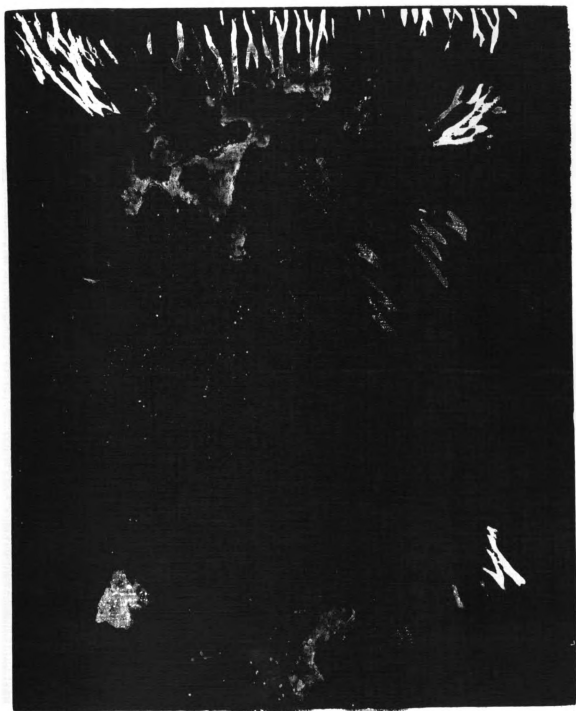














APPENDIX B

DATA COLLECTING DEVICES

Final Data Response Sheet

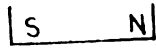
Name _____

Observation Date _____

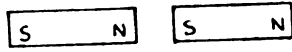
Distinguishing

Directions: Given a magnetic photogram of each of the following magnetic fields as indicated by their magnetic lines of force, the participant will study the lines of forces; use the available equipment provided for him and reproduce the arrangements of the magnets by Distinguishing between attraction-attraction lines of force, the attraction-repulsion lines of force, the repulsion-repulsion lines of force, the lines of force created by the end of; a bar magnet, a round magnet and a horseshoe magnet.

	Responses	
	Could	Could not
1. One Bar Magnet		
2. Two Bar Magnets (N-S)		
3. Two Bar Magnets (N-N)		
4. Two Bar Magnets (N-Washer-)		
5. Two Bar Magnets (N-washer-N)		
6. One Bar Magnet Upright		
7. One Round Magnet Upright		
8. One Horseshoe Magnet Flat-side		
9. One Horseshoe Magnet Pole Upright		
10. One Bar Magnet N-Unmagnetized steel		
11. Two Bar Magnets At Right Angles-Centered		
12. Four Bar Magnets (N-S-N-S) at right angle		
13. Four Bar Magnets (N-N-N-N) at right angles		
14. Four Bar Magnets (N-N-N-S) at right angles		
15. Four Bar Magnets (N-N-S-S) at right angles		
16. Magnetic Reacting Pile-Non-Magnetic Reacting Pile		
17. Magnet Beneath Setup-Distinction Tasks		
18. Distinction Tasks of Strongest Part of Magnet		
19. Four Photograms Different Size Washers		
20. Diagrams: A-Non-magnetic "stuff", B-Magnetic "stuff"		



2)



3)



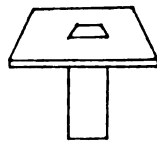
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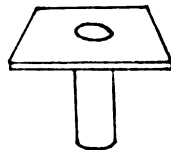
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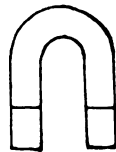
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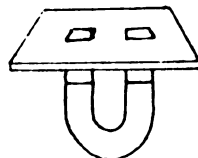
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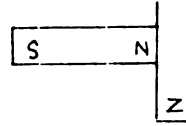
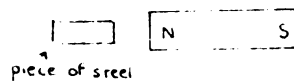
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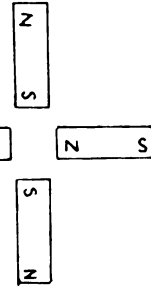
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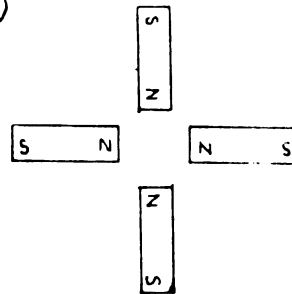
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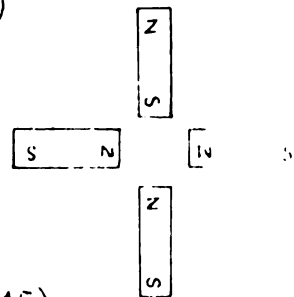
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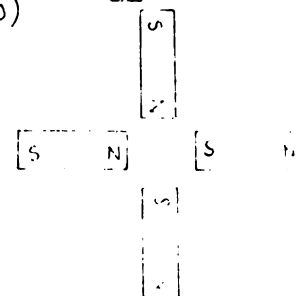
13)



14)



15)



16. In this container there are two kinds of "stuff"
- 1) Those which react to magnets
 - 2) Those which will not react to magnets

Dump the "stuff" out on your table or desk top. Now make two heaps or piles of "stuff", by using your magnet to separate the "stuff". Then correctly place the two signs given to you for distinguishing each pile as either (1) magnetic reacting pile or (2) non-magnetic reacting pile.

17. With this set up identify the type magnet beneath the paper, now distinguish the type magnet used beneath the paper from the second magnet in front of you by sprinkling iron filings on the set up and observing its magnetic lines of force.
18. Using a round magnet, a container filled with washers using the follow up activity from the first telecast furnished you. Identify the strongest part of the magnet and distinguish between the parts by giving an acceptable name for each.

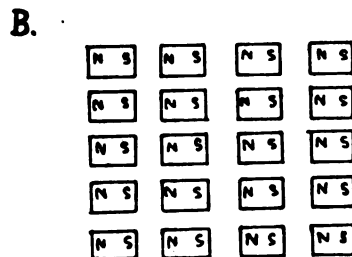
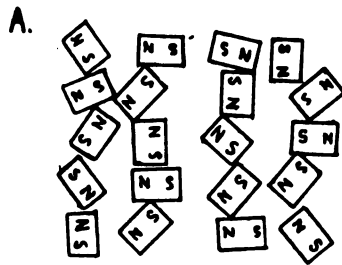
Identification _____

Distinction by names:

1) _____

2) _____

19. Take these 4 photographs, made with four different size washers and distinguish between them by arranging them in order of increasing size of washer. (Begin with the smallest washer first).
20. With the two diagrams below, distinguish between the diagram which represents a magnetic piece of "stuff" from a non-magnetic piece of "stuff" by pointing out the correct alphabet in the diagrams for magnetized "stuff" and unmagnetized "stuff".



art work by
marcia Rohatynski

EXPERIMENTAL RAW DATA AND PERCENTAGE SCORE							
RAW SCORES				RAW SCORES			
PIDN**	Pretest	Post Test	Calculated Percentage	PIDN**	Pretest	Post Test	Calculated Percentage
1.)	0	15	75	35.)	2	18	90
2.)	3	17	85	36.)	2	16	80
3.)	3	17	85	37.)	2	16	80
4.)	3	17	85	38.)	2	16	80
5.)	3	19	95	39.)	2	17	85
6.)	3	16	80	40.)	2	17	85
7.)	3	16	80	41.)	2	17	85
8.)	3	17	85	42.)	2	16	80
9.)	3	16	80	43.)	2	16	80
10.)	3	16	80	44.)	2	17	85
11.)	3	16	80	45.)	2	16	80
12.)	3	18	90	46.)	1	15	75
13.)	3	17	85	47.)	1	16	80
14.)	3	16	80	48.)	1	17	85
15.)	3	17	85	49.)	1	16	80
16.)	3	17	85	50.)	1	17	85
17.)	3	16	80	51.)	1	17	85
18.)	3	17	85	52.)	1	17	85
19.)	3	16	80	53.)	1	17	85
20.)	3	16	80	54.)	1	16	80
21.)	3	14	70	55.)	1	17	85
22.)	2	15	75	56.)	1	17	85
23.)	2	18	90	57.)	1	17	85
24.)	2	17	85	58.)	1	17	85
25.)	2	16	80	59.)	1	17	85
26.)	2	17	85	60.)	1	17	85
27.)	2	17	85	61.)	1	15	75
28.)	2	16	80	62.)	1	17	85
29.)	2	19	95	63.)	1	16	80
30.)	2	17	85	64.)	1	17	85
31.)	2	17	85	65.)	1	15	75
32.)	2	17	85	66.)	1	17	85
33.)	2	18	90	67.)	1	17	85
34.)	2	15	75				

*Participant's Identification Number.

<u>Name</u>	<u>Position Held</u>	<u>Department/Job Function</u>	<u>Action Taken</u>	<u>Replacement</u>
Edward E. David	Director	Office-Science & Technology	Resigned	None
	Chairman	President's Science Advisor President's Science Advisory Committee	Resigned	None
John Baldeschwieler	Deputy Dir.	Office-Science & Technology	Resigned	None
Elliot Richardson	Secretary	Department of HEW	Reassigned	Yes
John G. Veneman	Undersecretary	Department of HEW	Reassigned	Yes
Meklin K. DuVal	Asst. Secretary	Department of HEW	Reassigned	None
Jesse L. Steinfeld	Surgeon General	Department of HEW	Reassigned	None
Robert Q. Marston	Director	Health Service & Mental Health Administration	Reassigned	None
Vernon E. Wilson	Commissioner	Federal Drug Administration	Reassigned	None
Charles C. Edwards	Commissioner	Federal Drug Administration	Reassigned	None
Caspar W. Weinberger	Official	Office-Management & Budget	Promoted	None
Frank C. Carlucci	Official	Office-Management & Budget	Promoted	None

<u>Name</u>	<u>Position Held</u>	<u>Department/Job Function</u>	<u>Action Taken</u>	<u>Replacement</u>
John F. Sherman	Deputy Dir.	National Institute of Health Administration	Promoted	None
John S. Foster	Director	Defense Research and Engineering	Resigned	None
Robert L. Johnson	Ass't. Secretary	Research and Development Agency	Resigned	None
Robert A. Frosch	Ass't. Secretary	Research and Development Navy	Resigned	None
Grant L. Hansen	Ass't. Secretary	Research and Development Air Force	Resigned	None
Gardiner L. Turner	Ass't. Secretary	Systems Analysis	Resigned	None
Ned D. Bayley	Dir. Science Education	Department of Agriculture	Resigned	Office Abolished
H. G. Stever	Director	National Science Foundation	Remained	
Raymond L. Bis	Deputy Dir.	National Science Foundation	Remained	
Thomas B. Owen	Ass't. Director	National Science Foundation	Remained	

<u>Name</u>	<u>Position Held</u>	<u>Department/Job Function</u>	<u>Action Taken</u>	<u>Replacement</u>
Edward C. Creitz	Ass't. Director	National Science Foundation	Remained	
James R. Schlesinges	Chairman	Atomic Energy Commission	Reassigned	None
Frank Clark	Deputy Under-secretary	Department of Interior	Returned to Geo. Survey	
John D. Whittaker	Presidential Assistant	Environment	Promoted	None
Harold B. Finger	Ass't. Secretary	Housing and Urban Development	Resigned	None
Robert Cairns	Deputy Ass't. Secretary	Department of Commerce	Resigned	None
James H. Wakelin	Ass't. Secretary	Department of Commerce	Resigned	None
Richard W. Roberts	Director	National Bureau of Standards	Appointed	

Figure 1.

 139 Ibid.

TABLE 26.--Two cell Chi-square calculation.

Source	DF	F-Value	P
Chi-Square	1	10.827	.001

*Significant at .05 level

F = 42.88

Assuming Equal Frequency under the Null H.*

TABLE 27.--Percentages based on post-test achievement raw scores.

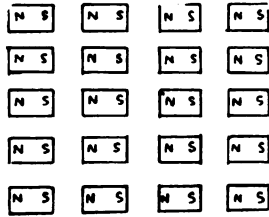
Percentage	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Distribution	—	—	—	1	6	21	33	4	2	—
Above 80%	—	—	—	—	—	21	33	4	2	—

*Sixty participants received 80% of the material
and represent 89.4% of the participants of the study.

APPENDIX C

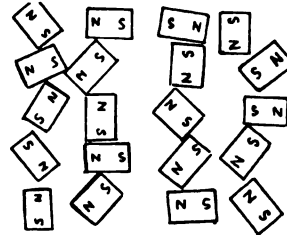
EYE OPENER WORK BOOK

MAGNETISM



"EYE OPENER"

Work Book



An Empirical Study Using
Fifth and Sixth Grade
Participants. (Inner City)

EVALUATION MODEL - NON VERBAL

Conducted by Wes Walker

art work by
Marcia Rohatynski

OBJECTIVES FOR EYE OPENERS

Eye Opener I - An Investigation With Magnets



Objectives:

1. The learner should be able to recognize the objects that are affected by magnets and those that are not affected by magnets.
2. The learner should be able to distinguish between the composition of the materials magnets affect and do not affect.
3. The learner should be able to name and classify the objects that are affected and not affected.
4. The learner should be able to identify the abilities and differences of each type magnet.

Prerequisite:

The learners should have viewed the telecast entitled - "Magnetic Materials."

Materials:

A horseshoe magnet
 A U-shaped magnet
 A bar magnet
 Paper clips
 Tooth picks
 Thumb tacks
 Rubber bands
 Brass paper fasteners
 Nails



What To Do:

Study the diagram (pictures) and do the experiment, name and group the materials in separate piles.

Eye Opener 2 - A Fish Pond GameObjectives:

1. The learner should be able to identify that portion of the fish that is affected by the magnet.
2. The learner should be able to name the basic material used in the finished product which attracts the magnet.
3. The learner should be able to distinguish between non-magnetic and magnetic substance.

Prerequisite:

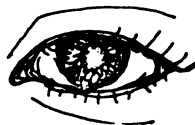
Successful completion of Eye Opener 1.

Materials:

- Several sheets of unruled paper
- Paper clips
- Gummed reinforcement
- Four sticks of wood about a foot long ($\frac{1}{4}$ " dowels)
- Four small horseshoe magnets
- A large glass bowl
- Card

What To Do:

- (1) After making your fish, place a number from 0 to 10 (for examples: 0-1-2-3-4-5-6-7-8-9-10) on each fish.
- (2) Divide the class up into four parts, choose a captain, who will fish for your team. All captains will place their "hooks" (made of a magnet, string, and a dowel) in at the same time.
- (3) When the fish are pulled out, look at the number on the fish and record it for each fish. At the end of game add up the total to see what team won. Notice where the hook catches the fish.

Eye Opener 3 - The Walking Gym ClipObjectives:

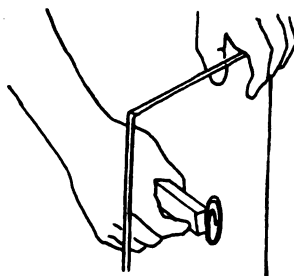
1. The learner should be able to definitely recognize the fact that magnets do attract certain substances made of iron/steel.
2. The learner should be able to describe what happens and the action of the paper clip in this eye opener.

Prerequisite:

Successful completion of "eye openers 1, 2 and the viewing of the telecast "Magnetic Materials."

Materials:

- A gym clip (paper clip)
- A strong permanent magnet
- A 5x7 inch piece of clear glass

What To Do:

- (1) Put the paper clip or gym clip on the opposite side of the glass, hold the piece of glass in one hand and the bar magnet in the other. Move the bar magnet and watch the gym clip. What happens?
- (2) Question--Have you come to the conclusion yet that iron is the most common of all magnetic materials, and that nickel and cobalt are magnetic but not as much as iron? An alloy (mixture of metals) of aluminum, nickel, cobalt, and iron makes a strong magnet called Alnico magnet.

Eye Opener 4 - Attraction and RepulsionObjectives:

1. The learner should be able to identify the two ends of the magnets which will and will not come together.
2. The learner should be able to describe what happens when two N-N poles are close to each other; when N-S poles are close to each other; and when the S-S poles are close to each other.
3. The learner should be able to describe the results of their experience in their own words in enough detail so that descriptions are identifiable as definitions of attractions and repulsions.

Prerequisite:

Successful completion of eye opener three and an understanding of how magnets affect iron and steel.

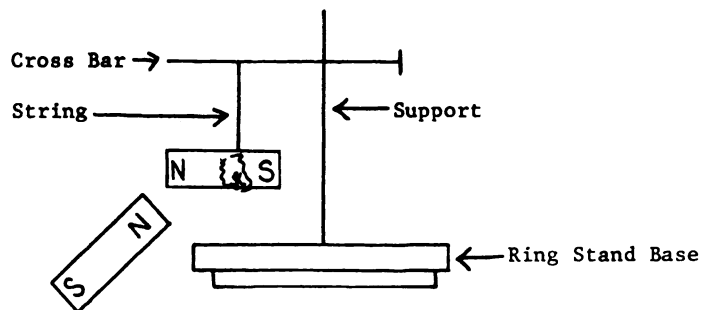
Materials:

1. Two permanent magnets whose poles are identified by N and S (North and South).



2 magnets

2. 1 - Ring stand set up and cross bar:



Eye Opener 4 (Continued)What To Do:

- (1) Set up the ring stand in the same way that is shown in the diagram.
- (2) Put the cross bar on with the stuff or material provided.
- (3) Tie a piece of string from the bar about 6 inches long.
- (4) Tie a magnet support which will be furnished for you to it, and place one magnet in it.
- (5) Bring the two ends of each magnet marked with an "N" on each together.

Observe what happens and discuss it with partner.

- (a) Identify the two ends of the magnets which will not come together.
- (b) Describe what happens when the N and N are close to each other; the N-S are close to each other and when the S-S are close to each other.

If repulsion is pushing away from each other, and attraction is coming together of each other.

Name each action - either attraction or repulsion.

Eye Opener 5 - Attraction and RepulsionObjectives:

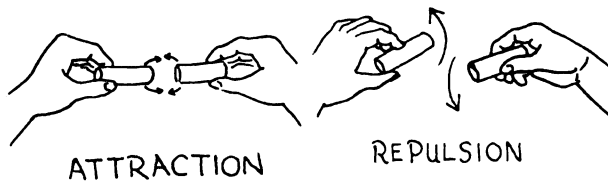
1. The learner should be able to describe what he feels as a results of bringing the like poles of two magnets together, and two unlike poles of two magnets together.
2. The learner should be able to distinguish between attractions and repulsions based on his description of what he felt happening with the magnets.

Materials:

Two bar magnets

What To Do:

- (1) Look for the north pole on the magnets. You will find the "big N".
- (2) Hold the two magnets, one in each hand, with the two N-poles facing each other.
- (3) Slowly bring them together, see if you can make them touch and stick to each other.
- (4) Describe in your own words what happens, and how your hand acted.
- (5) Now turn the two S-poles together and bring them together in the same way as before.
- (6) Describe in your own words what happened and how your hand acted.
- (7) Now take the two magnets, one with the N-pole showing and the other with the S-pole showing.
- (8) Bring them together slowly. Now tell in your own words what happened. How did it feel?

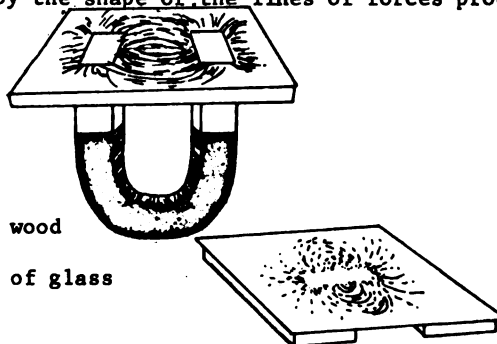


Eye Opener 6 - Lines of ForcesObjectives:

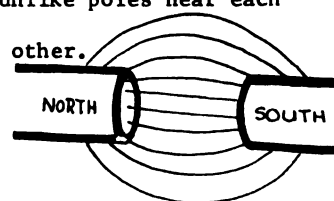
1. The learner should be able to recognize what happens when iron filings are spread over magnets and name this action as lines of force.
2. The learner should be able to describe what happens when: N-N poles are sprinkled; N-S poles are sprinkled; S-S poles are sprinkled; S-N poles are sprinkled.
3. The learner should be able to distinguish between unlike pole patterns and like pole patterns by the shape of the lines of forces produced.

Materials:

- 1 - Horseshoe magnet
- 2 - Bar magnets
- 2 - Thin books or pieces of wood
- Stiff card board or a sheet of glass
- Iron filings

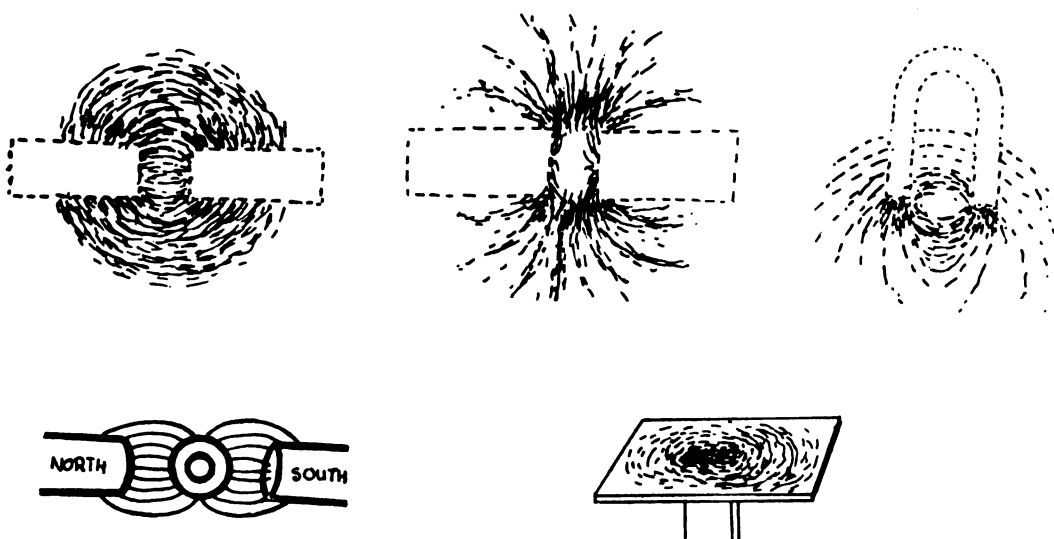
What To Do:

- (1) Lay the thin books or pieces of wood on the desk or table apart from each other 4 or 5 inches.
- (2) Place the magnet between the books or wood but not touching the books or wood.
- (3) Place the piece of poster board or glass over the books, magnets and/or wood, so that it rests on the book/wood.
- (4) Sprinkle the iron filings on the poster board or glass. If the iron filing is too crowded give the poster board a sharp tap with the fingers. (If you don't understand, call your teacher.)
- (5) Next place two magnets between the books with their unlike poles near each other but be very careful that they don't touch each other.



Eye Opener 6 (Continued)

- (6) Place the card board on top again; and sprinkle the filings. What happens?
Can you describe it? Notice how the filing is shaped with unlike poles.
- (7) Now place the magnets so that the two N-N pole face each other. Place the card board over them again and sprinkle the filings again. If a quick tap from the fingers is needed, do so. Then notice the arrangement of the filings. Are they different? If so, how?
- (8) Now place the horseshoe magnet between the supports of wood or books, place the poster board over them and sprinkle the filings again, describe the shape of the filings.
- (9) Something to wonder about:
What will happen if three or more magnets arranged in many ways were used? Try it!
- (10) Now try placing different size washers between the magnets. You choose how you would want them to go. Describe what happens.
- (11) Now hold a bar magnet in your hand. Let your partner hold the poster board over the top of the magnet, sprinkle the filings on the poster board, describe what happened.





Eye Opener 7 - Magnetism Passes Through Most Substances

Objectives:

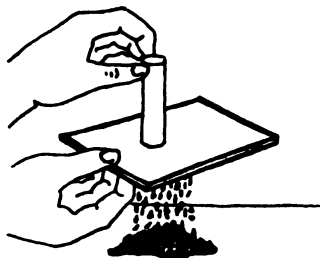
1. The learner should be able to recognize the fact that magnetism passes through most substances.
2. The learner should be able to identify the substances which will not allow magnetism to pass through it.

Prerequisite:

The successful completion of Eye Opener 6 - Lines of Forces.

Materials:

Ring stand base
 Ring stand rod
 Cross bar
 Paper clip
 Thread
 Small pieces of glass
 Paper
 Rubber
 Copper
 Aluminum
 Sheet iron

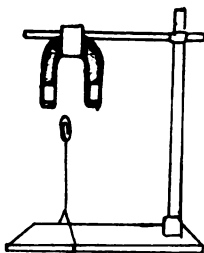


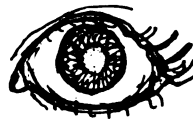
What To Do:

- (1) Arrange the apparatus as shown in the figure below as a support
- (2) Tie the thread to the paper clip.
- (3) Fasten the thread to the base of the stand but do not tie it. (To allow for adjustment and also to determine the extent of the magnetic field by raising and lowering the clip. When the clip falls freely as a results of lowering it by pulling on the string, the magnetic field is no longer acting upon it strong enough to counter act the opposing force.)

Eye Opener 7 (Continued)

- (4) Allow the paper clip to come as close to the magnet as possible without touching, and also leave enough room for passing materials through the opening with touching magnet nor clip.
- (5) Now pass through the opening the samples on hand and observe what happens.





Eye Opener 8 - Photogram of a Magnetic Field

Objectives:

1. To produce a permanent record of a magnetic field so that the children can describe what happens in the formation of the magnetic fields depending upon what magnets were used.
2. To be able to recognize, attraction, repulsions, and name by use of the words "like and unlike" poles used as shown by the shape of the lines of forces.
3. To be able to distinguish between types and shapes of magnets used after seeing their fields.
4. Be able to give the specific order in which the chemical process occurred used for making the photograms.

Prerequisite:

Successful completion of Eye Opener 7.

Materials:

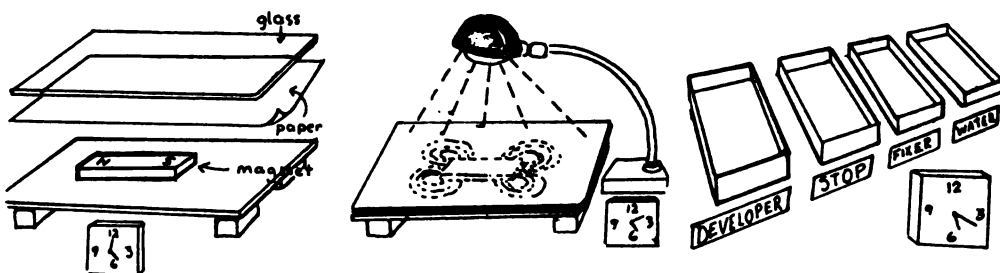
Photographic paper - 8x10 inch sheets (Kodak Velox F2 or AD-Type A-4
 Desk lamp (100 watt bulb, 60 watt bulb or photographic enlarger setup)
 4 - Shallow pans per set up or large plastic pans used for storage.
 Kodak Dektol Developer, Fixer-Stop Bath
 Timer
 2 - 10 x 12 inch pieces of plexiglass
 Iron filings in shaker
 Various type magnets
 Rubber hammer used with tuning forks.

What To Do:

- (1) Arrange the magnet, ~~plexiglass~~ photo paper in a sandwich as shown in the following diagram (1).

Eye Opener 8 (Continued)

- (2) Pull the shades and switch off all the lights in your classroom, before exposing the paper.
- (3) Sprinkle iron filings on the paper over the area above the magnet.
- (4) Tap the plexiglass with the hammer so that the filings will cover the magnetic field.
- (5) Place the desk lamp over the magnetic field about 10-12 inches high. (See Figure 2.)
- (6) Expose the whole setup for about five seconds.
- (7) Now remove the Velox paper from between the two panes of glass.
- (8) Set up the developing pans in the following order: 1) Developer, 2) Stop Bath, 3) Fixer, 4) Water. (See Figure 3.)
- (9) Be sure to mix the chemicals according to directions.
- (10) Place the exposed Velox paper into the developing solution and agitate for one to two minutes or until the exposed areas are black and the areas where the filings were are white.
- (11) Now place it in the stop bath for about 20 seconds.
- (12) Next place the paper into the fixer for about 10 minutes.
- (13) Now wash the print in water for twenty minutes.



APPENDIX D

ELECTROMAGNETIC (AUDIO)

TAPESCRIPTS

Script for Electromagnet Tape
For TV production of magnetic materials

Introduction to Class

On our first telecast we asked the question - "How many different kinds of objects do you think one effected by magnet?"

(This is played back from TV excerpt:)

Today we are going to use the equipment furnished for each of you and with the chart furnished for you and the sheet labeled conductors and non-conductors, we will investigate this for ourselves.

"First we go all of our material in front of you."

PAUSE 5 SECONDS

"Take your magnet in your hands and bring the magnet in contact with the materials in the container."

PAUSE 10 SECONDS

"Remove the magnet along with what every comes out, put each different kind of material in a different pile."

PAUSE 10 SECONDS

"Now list in the spaces, the number of thumb tacks, nails, washers or whatever removed in the proper space beside the number 1 and under the word response write "y" for each material removed and "n" for those not removed on that trial."

PAUSE 25 SECONDS

"Continue doing this until you have removed all of the things that the magnet will remove."

PAUSE 20 SECONDS

"Now with your hands, pick up and separate the stuff that the magnet did not get, and separate it and count each one."

PAUSE 20 SECONDS

"Now write down the number of each in the space provided."

PAUSE 20 SECONDS

"Now write the name of all the things the magnet did not pick up under the NON-CONDUCTOR LIST on the second piece of paper."

PAUSE 20 SECONDS

-2-

"Now write the name of all the things left under the conductors list on the same piece of paper, the spelling of each is found on the bottom of the sheet. If you need help, raise your hand."

PAUSE 30 SECONDS

"In your work book is another activity very much like this one you are to work in a group of 3 people each and carry out the same kind of activity. Look in your work book at the first investigation try to name to each other all of the stuff found there then do your activity the same as you did this one. You will not have to write anything. Read the pictures and do your experiments."

Thank you.

Electromagnetic Tape Script 2

Today boys and girls we shall try to determine what will happen if we place a whole magnet into the container of iron washers.

First find your magnet placed in front of you.

PAUSE 5 SECONDS

Dip your magnet very gently into your washers, be sure that it's down as far as it can go.

PAUSE 10 SECONDS

Now lift your magnet out very very carefully and notice where the washers are attached. Write it down as simply as possible.

PAUSE 10 SECONDS

Now take some wire tacks or iron filings and place them on a flat sheet of paper and move the magnet around in them and see what happens, write it down as simply as possible. Clean the magnet off.

PAUSE 10 SECONDS

Now turn the end of the magnet straight up and push it down in the tacks, lift it out, and notice where the tacks are.

PAUSE 10 SECONDS

Brush the tacks off and do the same thing with the other end, lift it out gently and notice where the tacks are.

PAUSE 10 SECONDS

Try any other type magnet and notice what happens when you put it in the dish of washers or tacks. Can you suggest where the strength of the magnet is?

PAUSE 10 SECONDS

If not, try pouring iron filings along the entire length of the magnet, pick it up, turn it over once gently, then look to see where there is still iron filing. Now can you tell?

PAUSE 10 SECONDS

Try touching a nail head with the middle of a bar magnet. Then touch it with the end of the magnet. What happens? If you have not found out where the bar magnet is strongest, then we shall try some other investigations different from these but will give the same clues. Switch off recorder.

Thank you.

Electromagnetic Tape 3 (Eye Opener 2)

Today we shall look closer at two kinds of "stuff" reacting a a magnet. But first you must make your fish needed for the game.

First take the unruled paper and the samples of the fish, and trace on the unruled papers three fish, and cut them out (turn on recorder).

After a pause of 8-10 minutes (turn on recorder).

Now paste a gummed reinforcement near the mouth of each fish you cut out.

Pause 30 seconds.

Push a paper clip both through the center of the gummed reinforcement and the paper.

Pause 10 seconds.

Somewhere on the fish trace a circle with the inside of a gummed reinforcement.

Pause 8 seconds.

Now write any number between 0-10 on the fish in the circle drawn by you.

Pause 5 seconds.

Make your fish look real by coloring the fish, but do not color the circle with the number in it.

Pause 20 seconds.

Tie the horseshoe magnet on a piece of string and tie the string to the wood. Make the string 18 inches long.

Pause 30 seconds.

Now place all of the fish in the bowl.

Pause 5 seconds.

Now turn to Eye Opener 2 in your workbook and wait for the signal to begin fishing from the instructor.

Electromagnetic Tape 4 (Eye Opener 4)

In this investigation you will see how the poles of the magnets react to each other.

First look at both ends of the magnet, find the end with the N on it, then look for the S end.

Pause 5 seconds.

Now do the same thing for the other magnet.

Pause 5 seconds.

Place one magnet flat on your desk, use the other magnet to try and lift the magnet on the table.

Pause 10 seconds.

When you lift the magnet, look at the two letters on the two magnets and write them down telling which end picked up the other. Use the N and S to tell.

Pause 8 seconds.

Now set the ring stand up as shown in the picture in your workbook.

Pause 20 seconds.

Now screw on the cross bar.

Pause 10 seconds.

Tie a piece of string about 6 inches long from the cross bar tying it to the magnet holder. (stirrup)

Pause 25 seconds.

Bring the N pole of the magnet in your hand close to the S pole of the magnet in the holder. Do it very slowly one or two times. (What happened?)

Pause 10 seconds.

Now do it fast. (What happened?)

Pause 15 seconds.

Now bring the S pole in your hands close to the N pole of the magnet in the holder slowly as before. (What happened?)

Pause 10 seconds.

Now bring the S pole to N pole fast. (What happened?)

Pause 10 seconds.

Electromagnetic Tape 4 (continued)

Bring the N pole of the magnet in your hands to the N pole of the magnet in the holder slowly first, then fast. (What happened?)

Pause 10 seconds.

Bring the S pole of the magnet in your hands to the S pole of the magnet in the holder slowly first . . . then . . . fast! (What happened?)

Pause 10 seconds.

Discuss what happened and look at Eye Opener 4 observation part and complete your work.

Thank you.

Electromagnetic Tape 5 (Eye Opener 5)

Now that we have notice the difference in responses of the magnets in our lesson before this, let's see if we can actually feel the difference between these two actions and name them from their action.

Look for the north pole on the magnet. You will find the "big N."

Pause 10 seconds.

Hold the two magnets, one in each hand between the thumb and the index finger (pointing finger next to the thumb) with the big N on one facing the big N on the other.

Pause 10 seconds.

Now slowly bring them together.

Pause 8 seconds.

See if you can make them touch and stick to each other. (What happens?)

Pause 10 seconds.

Write in your own words, what happened and how it made your hands feel and how they acted in your hands. Write this down.

Pause 25 seconds.

Now find the big S on both magnets, hold them the same way as before.

Pause 10 seconds.

Slowly bring the two S ends together and make them touch.

Pause 10 seconds.

Write down what happened.

Pause 15 seconds.

Now take the two magnets one with the big S showing facing the other with the big N showing.

Pause 10 seconds.

Now bring them close together. What happened? Write it down telling how they felt.

Thank you.

Electromagnetic Tape 6 (Eye Opener 6)

In this investigation we shall look at the shapes of the magnetic field by producing lines of forces with iron filings which will take the shape of the magnetic field. We are not seeing the magnetic field on the way that the iron filing is arranged to represent the field.

First lay the pieces of wood provided for you about 4 to 5 inches.

Pause 10 seconds.

Place a single bar magnet between the two pieces of wood.

Pause 10 seconds.

Now lay the poster board on the wood support across the bar magnet so that it rests on both pieces of wood.

Pause 10 seconds.

Take the iron filing, sprinkle it on the poster board very evenly.

Pause 20 seconds.

If the iron filing is too crowded in places, give the poster board a sharp but gentle tap with the fingers. (If you don't understand how, raise your hand and the teacher will show you.)

Pause 10 seconds.

Watch the magnetic field and notice the shape of it.

Pause 10 seconds.

Dump the iron filings on the paper furnished for you and put it back in the shaker.

Pause 30 seconds.

Now place two magnets between the wood supports with one S pole and one N pole in the same direction near each other. Be sure they don't touch.

Pause 10 seconds.

Now place the card board on top of the wood support covering the magnets again.

Pause 15 seconds.

Sprinkle the iron filing as before and describe what happens and draw the shape the iron filing makes with unlike poles near each other.

Pause 20 seconds.

Electromagnetic Tape 6 (continued)

Remove the iron filing and pour it back in the shakers the same as you did before.

Pause 20 seconds.

Now place the two magnets so that the N pole of one and the N pole of the other face each other laying in the same direction.

Pause 10 seconds.

Place the card board over them and sprinkle the iron filing on the poster board again. If a quick tap from the finger is needed, do so.

Pause 10 seconds.

Notice the arrangements of the filings, are they different? If so, how?

Pause 10 seconds.

Try to draw what they look like to you.

Pause 30 seconds.

Now dump the filings into the sprinkler again.

Pause 20 seconds.

Now place three magnets between the two wood supports. With N pole laying aside and N pole as before.

Pause 10 seconds.

Now bring the third pole from the other end with the S pole facing the two N-N poles.

Pause 15 seconds.

Now cover with the poster board, and sprinkle with filings.

Pause 10 seconds.

Describe and draw the shape you now see on the magnetic field.

Pause 20 seconds.

Now replace the filings in the sprinkler.

Pause 15 seconds.

Now place a horseshoe magnet between the two pieces of wood.

Pause 10 seconds.

Electromagnetic Tape 6 (continued)

Place the poster board over the magnet and supports.

Pause 5 seconds.

Sprinkle the filings on the poster board and notice the shape of the magnetic field.

Pause 10 seconds.

Draw the shape of the field you see.

Pause 30 seconds.

Now return the filings to the sprinkler.

Pause 10 seconds.

Using two bar magnets and four different size iron washers, arrange the bar magnets the following four ways and make magnetic fields.

Pause

N-O-N; all four sizes: N-O-S all four sizes and draw the fields. This will take some time. Use your workbook to help you if needed.

Thank you.

Electromagnetic Tape 7 (Eye Opener 7)

In this investigation we shall see how magnetism passes through mass things and notice that a certain type material will stop it sometimes.

First set up the apparatus as shown in the figure below with the ring stand set up and cross bar in place.

Pause 60 seconds.

Now tie about 12 inches of thread to the paper clip.

Pause 20 seconds.

Fasten the thread to the base of the stand but do not tie it.

Pause 15 seconds.

Tape a horseshoe magnet to the cross bar to keep it steady.

Pause 25 seconds.

Now bring the paper clip near the pole of the magnet but do not let it touch and adjust its position by pulling taunt on the string around the ring stand base.

Pause 3-5 minutes.
(Switch off recorder.)

(Note: Be sure that all samples will pass through without touching the magnet or paper clip.)

Recorder on:

Now pass all materials through the arrangement beginning with glass and ending with sheet iron, or nickel last. Write down what happened.

Thank you.

Electromagnetic Tape 8 (Eye Opener 8)

Today we shall make photograms of a magnetic field. These are yours to keep.

Arrange the magnet, glass, and photo paper in a sandwich as shown in the following diagram labeled No. 1.

Pause 60 seconds.

Pull the shades and switch off all of the lights in the classroom, before exposing the paper.

Pause 60 seconds.

Now sprinkle iron filings on the paper over the area above the magnet.

Pause 30 seconds.

Tap the glass gently with your finger or a pencil so that the filings will cover the magnetic field.

Pause 20 seconds.

Place the desk lamp over the magnetic field about 10-12 inches high (see figure 2 in your workbook).

Pause 60 seconds.

Expose the entire setup for about five seconds.

Pause 20 seconds.

Remove the Velite paper from between the two panes of glass.

Pause 30 seconds.

Set up the developing pans in the following order: (1) developer, (2) stop bath, (3) fixer, (4) water. See figure 3 in the workbook.

Pause 5 minutes.

Place the exposed Velite paper into the developing solution and agitate for one to two minutes or until the exposed areas are black and the areas where the iron filings were are white.

Pause 3 minutes.

Now place it in the stop bath for about 20 seconds.

Pause 30 seconds.

Next place the paper into the fixer for about 10 minutes.

Pause 12 minutes.

Now wash the print in water for twenty minutes.

Thank you.

APPENDIX E

TELEVISION SCRIPTS--EXCERPTS

AND COMMENTS

SCRIPT

SUBJECT Magnetic Material		DATE	TEACHER Wes Walker	TIME
CAMERA	VIDEO	AUDIO		
	<u>VIDEO</u> 1. Type card and slides 2. Two students pulling against strong magnets. 3. Talent Super-- <u>Magnetism</u> 4. Talent-Students Super-- <u>Force</u> (a) Typed card I - A push or a pull 5. Talent (Ken--move to activity set up before conclusion of speech.) 6. Demonstration I (a) Chart I (b) Super-- <u>Median</u> (c) Typed cards II (1) IIa (2) IIb (d) Super-- <u>Midpoint</u> 7. Talent (a) Activity or Demo II Place magnet in washers, collect and count washers.	<u>AUDIO</u> 1. Music 2. Music 3. Today we will begin talking about <u>magnetism</u> . 4. Dialogue with two students concerning their inability to pull materials apart. FORCE 5. Some things are attracted by magnets; others are not. What we will do is model and demonstrate a very difficult concept of science and try to avoid generalizations that are too abstractly detailed. 6. "How many different kinds of objects do you think are affected by magnets?" (a) We shall gather small samples of as many different materials we can find, to help discover which kinds of materials are attracted most by magnets and list them on our charts. (b) Introduce the concept median. (c) Definition of median. (1) Example of odd number set to determine median process. (2) Example of even number set to determine median process. (d) Median is the midpoint of a given set of numbers. 7. There are certain parts of our magnets that are stronger than others. "What do you think would happen if we place this whole magnet into this container of iron washers?" (a) Let's look at Activity 2.		

SCRIPT

PROJECT Magnetic Materials DATE

TEACHER Wes Walker

TIME

CAMERA

VIDEO

AUDIO

8. Shot on magnets instead of talent.Activity or Demonstration 3
Chart II(a) Super--Variables9. Shot of box for Activity or
Demonstration 4

10. Talent

11. Credits

8. Do you think that magnets will always lift the same number of items each time? "How can we decide on the number of washers it might lift? What do you think will happen if different magnets are used to pick up 'stuff'?" (The concepts of variables should be stressed here and the sizes and shapes should suggest a change in magnetic strength.)

(a) Demonstrate with the use of different size magnets pointing their sizes and counting the number of washers picked up.

9. What do you think would happen to the balls in this box if a magnet were placed beneath them?

"How would a moving magnet make other things behave?"

10. Summary

11. Music

Script I--Magnetic Materials, Excerpts and CommentsQuotes from T.V. Audio
or ActionBehavior and Duties of the
Classroom Teacher

- | | |
|--|---|
| <p>1. "How many different kinds of objects do you think will be affected by magnets?"</p> | <p>1. A chart of the same type used in TV studio will be in the classroom and replication of this chart on a ditto will be passed out to participants to be used in their discovery method for recording their findings.</p> |
| <p>2. "What do you think will happen if we place this whole magnet into this container of iron washers. (Begin count but don't complete it.)"</p> | <p>2. The classroom activity will be used to complete this activity.</p> |
| <p>3. "What do you think will happen if magnets are used to pick up "stuff." On the TV variables are mentioned, demonstrated, and listed. The classroom activity allows for students' perceptual development of variables: sizes of magnets, strengths of magnets, and age of magnets. Elementary components of magnets are discussed as in a class activity but not on ITV.</p> | <p>3. Ample and excessive time should be allowed for experimentation. This allows for holistic development of mental and organic interpersonal responses of learner to equipment and self. The concept of variables should be further discussed by the teacher.</p> |
| <p>4. "How would a moving magnet make other things behave?" This ends with magnetic materials but leads into magnetic fields.</p> | <p>4. The teacher focuses the attention of participants on the classroom activity found in the workbook which allows for many opportunities to experience force-fields. This makes it easier to discuss magnetic fields which is presented in the second television program and to stimulate interest in the area covered by the field and its relative strength.</p> |

REQUEST FOR VISUALS - Magnetic Materials**TEACHER** Wes Walker**SUBJECT** Science**DATE****DESCRIPTION OF VISUALS****DATE NEEDED****TIME**Supers:

1. Magnetism
2. Force
3. Median
4. Midpoint
5. Variables

Typed Cards:

1. Force - a push or pull
2. Median - the median is the midpoint between the first and last number of a given set of numbers

2a - Example

6
 7 odd number of given set
 9---midpoint
 16
 20

Here 9 is the median

2b

6
 7 even number of given set
 9---midpoint
 12
 16
 20

$$\frac{9 + 12}{2} = 10.5 = \text{The median}$$

SCRIPT

E.T.V. Script		TEACHER Wes Walker		TIME
SUBJECT	Magnetic Fields	DATE		
CAMERA	VIDEO	AUDIO		
	1. T.C. 2. Talent Super--<u>Atoms</u> Typed Cart I 3. Graphic I 4. Demonstration 5. Talent (a) Demonstration - Iron Filing and Magnets (b) Super--<u>North Pole</u> (c) Super--<u>South Pole</u> 6. Super--<u>Magnetic Fields</u> Typed Card II Graphics: 1-2-3 (<u>Photograms</u>) Super--<u>Magnetic Lines of Force</u> 7. Talent 8. Credits	1. Music 2. "Do you know why some materials are magnetic and some are not?" Scientist think that the atoms (tiny particles) of all materials are little magnets, each with another pole and south pole. (Typed card I atoms definition.) 3. Explanation of theory. 4. "Will the magnets react differently if physically arranged so that this theory can be tested? If so, how?" 5. "If magnets have poles, how do they react and are they the same?" How can we prove this, if true?" (a) Demonstration (b) North Pole (c) South Pole 6. A permanent magnet will exert a force on a piece of iron or on another magnet some distance away. "How does the space around magnets, where their effects are felt, interest us?" <u>Magnetic Fields</u> (a) Demonstration (b) North Pole (c) South Pole 7. Summary 8. Music		

Script II--Magnetic Fields, Excerpts and Comments

Quotes from TV and Audio

1. "Do you know why some materials are magnetic and some are not?" Diagrams of atoms as basic building blocks will be used to develop the concept of indivisible particles carrying "charges."
2. "Will the magnets react differently if physically arranged so that this theory can be proved?" This stimulates the demonstration of random arrangements of atoms and then perfect arrangements of atoms. Two things can be deduced: (1) the arrangement of atoms in an iron bar makes the difference between a magnetized iron bar and a non-magnetized iron bar.
3. "If magnets have poles, how do they react; and are they the same?" This leads into polarity (magnetic) and suggests that there might be a difference, but a test must be devised to find out. The children will use magnets and activities designed to investigate these possibilities.
4. "How does the space around magnets, where these affects are felt, interest us?" This provokes the concept of magnetic fields and suggests a means of testing their existence.

Behavior and Duties of the Classroom Teacher

1. The teacher will have a copy of similar diagrams and will promote discussion in classroom. Through discussion it can be shown that the theory is deduced not "proves." This also leads to the primitive source of the "force" being furnished.
2. The teacher will continue to emphasize these facts and repeat the experiment as a possible method to collaborate the fact that in an iron bar magnet the north poles of the atoms are almost all facing in one direction to create the north pole of the magnet, while the south poles of the atoms facing the other direction create the south pole of the magnet.
3. Teacher follow-up furnishes the classical two dimensional investigations which show lines of forces, poles, repulsions, attractions, and demonstration of the entire magnetic field. All of these will be participant activities.
4. The teacher now stresses the concept fields and demonstrates their existence through prescribed investigations. A graph similar to the one used on the TV will be available, and diagrams of smaller ones will be included in the student's workbook.

REQUEST FOR VISUALS - Magnetic Fields

TEACHER	<u>Wes Walker</u>	SUBJECT	<u>Science</u>
DATE	DESCRIPTION OF VISUALS	DATE NEEDED	TIME

Supers:

1. Atom
2. North pole
3. South pole
5. Magnetic fields
6. Magnetic lines of force

Typed Cards:

1. Atoms - basic unit structure of matter.
- II. Magnetic Fields - the force around the magnet which pushes or pull on things.

Graphic I

1. Model of manipulative device to demonstrate the magnetic theory.

APPENDIX F

CHARTS 1-12; SUPERS

TYPES CARDS

CHART I

RESPONSE CHART - LISTING AND RECORDING

ITEMS →	washers		brads		rubber-bands		rubber washers		paper clips		tacks	
	response	number	response	number	response	number	response	number	response	number	response	number
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

R = Responses of material to magnet

N = Number of items counted for each response

M = Median for each item

CHART II

NUMBERS
OF ITEMS

SIZES

SHAPES

LARGE

MEDIUM

SMALL

BARMAGNET

LARGE

MEDIUM

SMALL

HORSE SHOE

LARGE

MEDIUM

SMALL

ROUND

MEDIAN

The median is the midpoint between the first and last number of a given set of numbers.

6 7 9 12 16 20

↑
midpoint

Even number
of a given set:

$$\frac{9+12}{2} = 10.5 \text{ the median}$$

EXAMPLE

5

7

9

16

20

Odd number of
a given set:

9

Here

is the median

FORCE

A push or pull

MAGNETIC FIELDS -
THE FORCE AROUND THE MAGNET
WHICH PUSHES OR PULLS
ON THINGS.

**ATOMS -
BASIC UNIT STRUCTURE
OF MATTER.**

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