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AN ELEMENTARY TEACHER ENRICHES A SCIENCE PROGRAM

A Substantial Paper

Presented to

the Faculty of the Department of Education

Eastern Illinois University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Education

by

Ruth I. Good

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INTRODUCTION

Elementary Science, as it is known today, is considered a very new arrival in the curriculum. At one time it was taught, if at all, more or less incidentally and accidentally. Events of recent years, in our country and the rest of the world, have made the schools aware of the fact that science must be an important part of the elementary school curriculum.

The purpose of this study is to increase the writer's skill in assisting each child, in a class, to interpret his or her universe; to aid the writer in developing those behavior patterns within the child that help him become a worthwhile member of society; to assist the writer in becoming a more alert, understanding and fearless science teacher; to develop the characteristics for an intermediate grade science program that are flexible enough to be changed when occasion arises and broad enough to provide growth in each child's ability to interpret his own world.

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CHAPTER I

DEVELOPMENT OF SCIENCE EDUCATION IN THE AMERICAN ELEMENTARY SCHOOL

According to W. C. Croxton, elementary school science education had its beginning in the schools of Oswego, New York, at the time the Pestalozzian method was being felt in America.[1] This method substituted oral instruction based on sense perceptions of objects for the recitation of lessons from books. This was the beginning of the object lesson which tended to replace the mechanical memory methods of earlier schools.

Another important movement in the development of our present-day method of science education was the emerging of the nature study viewpoint. This movement has been credited to Henry H. Straight who studied with Agassiz in 1872 and 1874 and afterwards at Cornell and Harvard. He became professor of natural science in the Oswego Normal School in 1876. While teaching at Oswego, Professor Straight made the transition from the disconnected object lesson method to the study of things in their interrelationships.

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[1] W. C. Croxton, Science in the Elementary School (New York: McGraw Hill Company, 1937), Page 22.

Later he developed the nature study idea and turned to the correlation of subjects as a means of unifying educational experiences. This movement made headway during the period from 1884 to 1890. Cornell University assumed leadership in this movement during 1893. Here Liberty Hyde Bailey and Anna Botsford Comstock worked and produced many writings that are familiar to elementary teachers. One of these better known writings is the Cornell Nature Study Leaflets.[2] These leaflets are still being issued and still hold the distinction of being among the best science teaching aids available to the elementary teacher.

Croxton points out that it is interesting and important to note that both the object lesson and the nature study movement originated and developed in the elementary schools and teacher training institutions. The nature study movement contributed to an important aim of the elementary school science program by bringing the child into direct relationship with his environment.[3]

As civilization became more complex, another movement was on in science education. This movement began in the

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[2]Eva L. Gordon, Cornell Nature Study Leaflets (Published by the New York College of Agriculture at Cornell University, Ithaca, New York).

[3]Croxton, op. cit., p. 26.

colleges and high schools and moved into the junior high schools. This trend was known as the systematized science teaching activity. In junior high schools it became known as general science and in the lower elementary school it was called unit teaching. This movement gave us a much more critical selection and evaluation of subject matter in terms of life situations.

Finally, project activities were introduced. This indicated that science teaching was opening new fields of interest and satisfaction. Another trend that has become apparent in science teaching, during the last two decades is that of making the universe more meaningful to the individual as well as freeing him of superstitions and prejudices. In recent years there has been a rapid appearance of attractive science readers in the elementary classroom. Since this has taken place more attention has been given to the teaching of science, although perhaps more as a reading course than one of direct experimenting.

Gerald S. Craig points out in a recent educational bulletin that science education of today must assist in developing behavior patterns that are essential in a democracy. Some of these behavior patterns that are considered important by Craig are: (1) open-mindedness; (2) critical mindedness; (3) responsibleness; and (4) resourcefulness. The school must create feelings of being needed and belongingness. Science teaching should be consistent with the nature of the child.[4]

Craig indicates, in the following selection, that science learning is a continuous life process:

> So science may be considered an area of child development. Just as a child changes in size and weight, he is also changing in his interpretations of the environment. If he suffers from malnutrition, he is handicapped in his physical growth; and if he is induced to accept misconceptions, superstitions and dogmatic beliefs, his outlook on his surrounding world will be stifled.[5]

Today nature study has been more nearly given its proper place in the elementary school curriculum and more physical and chemical sciences are being taught. More uses are being made of community and human resources. Many sincere attempts to recognize individual differences in pupils are being initiated.

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[4]Gerald S. Craig, Science in the Elementary Schools (Washington, D. C., Dept. of Classroom Teachers, American Educational Research Association of the National Education Association, April, 1957), p. 4.

[5]*Ibid.*, p. 16.

CHAPTER II

RESEARCH SPEAKS TO THE CLASSROOM TEACHER CONCERNING SCIENCE TEACHING

School education is what happens to boys and girls under the leadership of classroom teachers. Well-qualified teachers will effectively help children to gain the objectives of the school program. The alert and sincere teacher is one who plans and instructs in harmony with the useful and worthwhile findings of educational research.

Research, according to Craig, may aid the classroom teacher as follows:

> (1) by helping him develop an alert, sensitive attitude to the advancing edge of human knowledge; (2) by supplying him with facts whereby he can improve his own work; (3) by stimulating him to go on beyond existing research findings to discover additional facts for himself.[6]

Today's classroom teacher has a much better chance of improving science teaching with information gained from research than did the classroom teacher of twenty-five years ago. Jacqueline Mallison is impressed by the increasing number of studies pertaining to elementary school science that are being produced. For many years very few were con-

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[6]Craig, op. cit., p. 1.

ducted. During the period from 1929 to 1952 less than four studies per year were published. During the school year 1952-1953 seventeen studies were published. Nineteen were made available during the years 1953 and 1954.[7] Thus, one may conclude that more research is being undertaken in the field of elementary science teaching.

The vast majority of studies published recently, and categorized by Mallinson, have been in the following problem areas:

> (1) the status of elementary science; (2) the grade placement of the science topics; (3) methods of enriching the curriculum; (4) the training of teachers.[8]

From a few of the more recent studies Jacqueline Buck and George Mallinson have concluded that there is a gradual trend away from the teaching of isolated facts and a general shift toward the teaching of large units of functional subject matter with the major aim of instruction being to help the child become familiar with his environment.[9]

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[7] Jacqueline Buck Mallinson, "What Have Been the Major Emphases in Research in Elementary Science During the Past Five Years," Science Education, XL (April, 1956), 206.

[8] Ibid., p. 206.

[9] Jacqueline V. Buck and George G. Mallinson, "Some Implications of Recent Research in the Teaching of Science at the Elementary School Level," Science Education, XXXVII-XXXVIII (February, 1954), 83-84.

From other studies, Buck and Mallinson have learned that there is value in organizing the science curriculum around other subject matter areas although surveys of practices indicate that most elementary science instruction still centers around the teaching of small, isolated topics.[10]

Two other surveys studied by Buck and Mallinson indicate that a great deal of research still needs to be done with respect to the teaching of scientific attitudes and problem-solving skills. Although these aims are accepted as major objectives of science instruction, it appears that most teaching still centers primarily around the dissemination of factual information. Another area of learning that needs to be investigated more fully is that of the use of laboratory exercises on the elementary level. The literature shows a large number of articles relating to this general area of learning, but unfortunately most of these are "opinion" articles rather than accounts of well-conducted research.[11]

The classroom teacher is always concerned with the grade placement of science topics. Jacqueline Mallinson points out that it may be possible to place tentatively a given topic of science at a specific age level, but it is

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[10] *Ibid.*, p. 98.

[11] *Ibid.*, p. 99.

practically impossible to place a broad area of science at a specific age level. This means that while it may be impossible for first grade children to master an understanding of a given principle related to electricity, it does not indicate necessarily that they are incapable of understanding anything about the general topic of electricity.[12]

It is generally agreed by authorities on science teaching in the elementary school that the teacher should be alert, fearless, critical and open-minded. The good present-day teacher has a wealth of knowledge about the learning abilities of children as well as how they learn, and the teacher applies this knowledge to the development of a science curriculum that is best for boys and girls.

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[12] Mallinson, op. cit., p. 207.

CHAPTER III

PREREQUISITES FOR AN ELEMENTARY SCIENCE PROGRAM

Points of view about elementary school science programs. It is very important that the pupil in the elementary school acquire as much science information as possible. This information is part of the essential equipment of the child of today. The child needs this information to help him answer the many questions he asks each day. This knowledge assists the child in forming rules of safe and healthful living and at times forms the basis for his every action.

Elementary teachers need to re-examine the kind of information they expect children to learn. Frequently pupils are required to memorize the names of structural parts of grasshoppers and katydids, or the names of insects, birds and blossoms without learning anything else about any of them. The elementary school program-maker must study many points of view concerning the science experiences and science information that are presented to children. The teacher should ever be on the alert for better ways of helping children develop their science potentialities. It is important that the teacher apply expert opinions to his or her classroom situation. Each class, as the teacher is aware, is made up of a group of individuals who respond differently and who have different interests, attitudes, behavior patterns and skills. Because of this, Blough suggests:

> To give significance to scientific information, the facts need to be gathered together into a generalization and applied to a meaningful situation. The generalization will be more limited in scope in the early grades; broader as pupils grow in ability to relate facts. Emphasis needs to be on information that makes a difference to boys and girls, because it relates to real problems, on information that will help them interpret the everyday scientific phenomena that they see, and on information that will help them grow in appreciation of and interest in the physical and natural environment. This organized information that seems essential to a well-rounded scientific background comes from such areas as the living things on the earth, the earth and the universe, physical and chemical phenomena, conditions necessary to life, and how man strives to control his environment. It is from these areas that pupils gradually acquire the organized knowledge that constitutes their science background.[13]

Herman and Nima Schneider feel that the curriculum maker needs a point of view, an orientation, that can bring the science curriculum into closer relationship with the child's growth and development. It is through what we teach and how we teach it, that we can help the child meet with confidence a rather complex and unstable world. As an

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[13]Glenn O. Blough, "Science in the Elementary School," Science for Today's Children, Thirty-second Yearbook of the Department of Elementary School Principals, (Washington, D.C.: National Education Association, Sept., 1953), p. 6.

example of this idea the Schneiders feel that the science program can help the child achieve a sense of the dynamics of change. As children grow into adulthood many of them never come to terms with change. They waste too much of themselves fighting change. In science there is endless opportunity for observing and recording change. If in the classroom, the children gain a feeling-tone of reasoned inquiry toward change, then perhaps they can be helped to live competently and happily in this age of swift change.[14]

George H. Hanley and Evelyn B. Schiesser state another point of view for science that must not be overlooked by the classroom teacher. This point of view is aimed at the tendency in the elementary schools to neglect the physical sciences in favor of nature study, the argument being that children are not ready for these fields until they are older or know more mathematics. The child in the elementary school needs a wealth of experience in the physical sciences in order to apply his later learnings in mathematics. Science readiness problems are like reading readi-

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[14]Herman and Nina Schneider, "Role of Science in Child Development," Science for Today's Children, Thirty-second Yearbook of the Department of Elementary School Principals, (Washington, D. C.: National Education Association, Sept., 1953), pp. 13-14.

ness problems, and the best solution of them are numerous and varied related experiences.[15]

Hanley and Schiesser fear that at times elementary science has become a "catch-all" containing health, recreation, safety, nature study, and conservation as well as science areas. The classroom teacher should look upon this list of studies with discouragement. The elementary teacher should be guided less by subject areas and the content of science books and more by natural interests of the children in themselves and in the things around them. The activities should answer questions and satisfy needs of the children themselves.[16]

Wilbur L. Beauchamp holds the point of view that,

> Science means different things to different people. To some it is the magic which produces radio, jet engines, television, and the hydrogen bomb. To others it is a body of tested knowledge which explains the world in which we live. Science of course is not magic. It is also a method of thinking -- a way of solving problems. Science has progressed as it has because scientists have invented and perfected a way of solving problems by experimentation.[17]

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[15]George H. Hanley and Evelyn B. Schiesser, "A Point of View for Science," Science for Today's Children, Thirty-second Yearbook of the Department of Elementary School Principals, (Washington, D. C.: National Education Association, Sept., 1953), pp. 17-18.

[16]*Ibid*., p. 19.

[17]Wilbur L. Beauchamp, "What is Science?" Science Notes, (Chicago: Scott Foresman Service Bulletin, 1956), Vol. 14, No. 2.

A belief that must not be overlooked is set forth by Herbert S. Zim. It is his belief that since great strides in psychology and child development have been made in the last century there have been changes in concepts of science and of science teaching. The newest concept of science as developed during the past century, tends to focus more and more on how to understand the world around us. The factual content of science is important, but the emphasis is increasingly on scientific methods.[18]

Zim believes that the classroom teacher will not be amiss in keeping the following simple concept of science in mind:

> Science involves observation; observation is enhanced by experiment and the use of equipment. The goal of observation is the discovery of facts which can often be applied to the solution of problems or the verification of previously discovered facts.[19]

R. Will Burnett points out that many teachers believe there is a conflict between spontaneity and coherence in elementary science experiences; that spontaneity is sapped from the program that is preplanned by a teacher or dictated by textbooks; that children's interest cannot provide a basis

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[18] Herbert S. Zim, Science for Children and Teachers (Washington: Association for Childhood Education International, 1953), p. 3.

[19] Ibid., p. 5.

or a program that is developmental and leads to durable and worthwhile science learnings. He states his position as follows:

> Desirable consistency and development of learning activities are impossible unless based upon the inherent impulses, promptings, and desires of the child. Spontaneity and coherence are the Siamese twins of successful elementary science experiences. They are but two dimensions of the same thing for the experiences -- the child. It is the teacher who tries to separate them.[20]

In light of the foregoing analysis, a worthwhile elementary science program should probably have as its objectives the following views that were set forth by a Study Group on Physical and Biological Sciences. This group had as its purpose the analyzing of the status of science teaching in the State of Illinois.

1. Helping youth understand, appreciate, and use the methods of science with special emphasis on the experimental approach.

2. Helping youth understand, wisely use, and develop an appreciation for their natural environment.

3. Helping youth understand the major laws of science.

4. Helping youth understand and use scientific information in maintaining personal and community health.

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[20]R. Will Burnett, "Spontaneity and Coherence in Elementary Science Experiences," <u>Science Education</u>, Vol. 40 (April, 1956) 195-196.

5. Helping youth understand that sicence has played a major role in the development of modern society and that continued progress will be greatly affected by the further achievements of science.

6. Helping youth understand that the fullest advancement of science and of mankind requires freedom of thought, inquiry, and expression.

7. Helping youth understand the relation of science to other fields of knowledge.[21]

Croxton believes there has been too much teaching children about science instead of helping children use science in living. This is perhaps because science is the newest and least developed part of the elementary school curriculum. On the whole it is not very well integrated into elementary education. Much of the science content of the elementary program has been derived from junior high school science instead of from studies of the roles of science in child-living.[22]

The following point of view concerning the teaching of elementary science, as stated by Craig, should not be overlooked:

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[21] R. Will Burnett, "Physical and Biological Sciences," Educational Press Bulletin, (Springfield: Office of Supt. of Public Instruction, Feb., 1957) p. 15.

[22] W. C. Croxton, "Needed Research in the Teaching of Elementary Science with Every Teacher a Researcher," Science Education, Vol. 39 (February, 1955), 17.

> A basic element to be considered by elementary school teachers is that science is "interpretation." The word "interpretation" is a more satisfactory and more inclusive term for describing what goes on inside a child and within the field of science than the words "explanation" or "understanding." Neither children nor science has final explanations or understandings of the happenings in the universe, but both children and science are involved in the active process of interpreting the physical world.[23]

Blough states that the sooner classroom teachers become aware of the fact that there is very little difference between good science teaching and good teaching of any other subject in the elementary school the better for boys and girls. It is important to always consider first the child -- his abilities, needs, interests and other characteristics.[24]

The nine-year-old child and his science capacities. As Craig very aptly states "Children are greater than science. Science has its importance in elementary education only as it serves boys and girls and through them the democracies of which they are a part."[25]

The writer, being a fourth-grade teacher, went to the researcher to learn those characteristics and behavior

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[23]Craig, *op. cit.*, p. 3.

[24]Blough, *op. cit.*, p. 7.

[25]Gerald S. Craig, "Children and Science," *Science Education*, Vol. 40 (April, 1956), 167.

patterns that are part of a nine-year-old child. The teacher of science is especially interested in those maturity traits that affect the science curriculum. The knowledge of these characteristics aid a classroom teacher in planning a science program as well as conveying science understandings and attitudes to the child. Arnold Gesell and Frances L. Ilg describe the following behavior patterns of the nine-year-old child.

1. He has a growing capacity to put his mind to things, on his own initiative or on only slight cues from the environment.

2. He is able to fill idle moments with useful activity.

3. Nine is preeminently an age when individuality seeks to reassert and to reorganize itself.

4. He has a greater interest in process and skill; he is more able to analyze his movements both before and during action.

5. He also is more interested and persistent in practicing his skills.

6. The extensiveness of Nine is engendered more from within. No one needs to tell him to make his expanding lists and inventories; nor to add new chemicals to his collection.

7. He is open to instruction; he is factual and forthright.

8. He is not too interested in magic, he has a healthy strain of skepticism.

9. He believes in luck and change; but he also believes in law; otherwise he would not be so

anxious to find out how things are done, and why they are what they are.

10. He seeks correction and explanation of his errors.[26]

The nine-year-old child does not enter school with zero knowledge concerning science. He has reacted during the past eight years to gravity, energy, lightning, thunder, darkness, light, weather and a host of other scientific phenomena.

As Craig relates, the nine-year-old has sensory capacities and intelligence which help him interpret his environment. He has gained certain concepts of roughness, smoothness, sharpness, lightness, heaviness, shininess, dullness, brightness, darkness, speed, acceleration, inertia, firmness, stability, instability, transparency, opaqueness, translucency, hardness, softness, and many other characteristics found in his environment. He has not learned all there is to learn about these concepts but has learned to associate them with his experiences.[27]

From birth a child has had to investigate his

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[26] Arnold Gesell and Frances L. Ilg, _Child Development The Child from Five to Ten_ (New York: Harper and Brothers, 1949), pp. 188-211.

[27] Craig, _op. cit._, p. 168.

environment, to find out what it is like and learn to feel at home in it. This urge to explore and investigate makes a child a true scientist. A child learns wherever he is either in the city or country, or beside an anthill or a window box. He clings to his basic urge to go and find out. He also carries with him the ability to learn in problem solving situations, be it in the midst of rules and safety or in unrestricted freedom.

It is not possible to take a clear look at the nine-year-old without considering differences in skills, stature, and social maturity. Each child has problems and these problems relate directly to the child's understanding of himself in relation to his environment. Science can help the child at this point. The process of science teaching has as its real aim helping the child find better ways of solving problems.

The child has a great deal of interest in science. Burnett reports that in a study in which children were asked to check the kind of books they liked best, over fifty percent of the bright boys and nineteen percent of the dull boys chose "science."[28]

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[28]R. Will Burnett, Teaching Science in the Elementary School (New York: Rinehart and Company, 1955), p. 17.

The questions that a child asks, Burnett points out, reveal a wide range of interests. They often reveal hurts, frustrations and personal problems that can be treated by the teacher who is willing to do so. There are no artificial divisions of science such as biological and physical. A child's questions cover a wide range of interests relating to astronomy, biology, chemistry, geology and physics. Some questions that a child might ask are:

> How does gasoline make a car go?
> How do worms get in apples?
> What are pollywogs?
> How do people know the world is round?
> Why do flowers bloom?
> What is noise?
> What makes light?
> What makes a mixmaster go?[29]

Peggy Borgan believes the child has the capacity to learn wherever he is. What he learns depends not only on the people around him but also on the relationship of these people to their physical setting.[30]

<u>The elementary teacher becomes better equipped to teach science</u>. It is a common belief among school personnel as well as lay persons that the teacher, more than any other

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[29] Ibid., pp. 13-14.

[30] Peggy Borgan and Lorene K. Fox, Helping Children Learn (Chicago: World Book Company, 1955), p. 28.

person on the school staff, determines the quality of the educative experiences provided the children in the classroom. Science instruction is no exception to this general principle.

Many experienced teachers have misunderstandings pertaining to the teaching of science. If one listens carefully in faculty meetings, he may hear expressed many erroneous beliefs concerning the teaching of elementary science. One of these erroneous beliefs is stated by Kenneth Freeman and Thomas I. Dowling as follows:

> Science means something highly technical that I know next to nothing about. Besides, I can think of no way in which this complicated and difficult thing I struggled with in college can give opportunity for enthusiastic learning activities for children.[31]

Murray Thomas points out that another teacher might say the following: "I don't know what the right kind of science program would be for my classroom so I suppose I just let the subject slip by without doing much about it."[32]

Many elementary teachers are hesitant about teaching

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[31]Kenneth Freeman, Thomas I. Dowling, Nan Lacy, James S. Tippett, Helping Children Understand Science (Chicago: John C. Winston Company, 1954), p. 11.

[32]R. Murray Thomas, "Finding the Right Science Program," Elementary School Journal, Vol. 53 (November, 1952), 156.

science because they feel that science is something foreign to them. Teachers may state various other reasons for not teaching science. G. G. Mallinson and J. V. Buck list, as follows, a few of the most frequently heard reasons:

1. The teacher has had little or no training in science.

2. Many teachers feel that they must have special apparatus and equipment in order to be able to teach science.

3. Many publications suggest that there is a "correct" way to teach science. Feeling uncertain as to just what the "correct" method entails, teachers avoid teaching science as much as possible.[33]

Gerald S. Craig states another reason why elementary teachers feel their own dearth of scientific knowledge. Teachers feel this lack of scientific knowledge when children ask questions for which they are not equipped to give adequate answers. Teachers need to remember that children's questions cover a wide field and that many of their questions have never been answered by the scientists. If at all possible, these questions should be used to motivate the science classes.[34]

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[33]George G. Mallinson and Jacqueline V. Buck, "A Bill of Goods," The Science Teacher, Vol. 20 (November, 1953), 299.

[34]Gerald S. Craig, A Program for Teaching, National Society for the Study of Education, Thirty-first Yearbook, Part I (Bloomington: Public School Publishing Company, 1932), p. 155.

It appears, then, that many classroom teachers have had inadequate preparation in science. Craig points out that this is particularly true of teachers who graduated from institutions of teacher education before courses designed to meet the modern needs of elementary science teaching had been introduced. There is evidence, however, that many teachers by utilizing the opportunities available in their own schools and communities, have become successful science teachers in spite of little or no science training in their academic and professional preparation.[35]

Ten years ago Craig pointed out that teachers were inadequately prepared for the teaching of science in the elementary classroom. Since then science teaching has been improving as a result of teachers' participation in science workshops and in-service programs. Improved science courses for elementary teachers offered by teacher education institutions have aided very much in improving the teaching of science in the elementary school. In spite of such opportunities for improvement, the more competent elementary teachers have learned that the best way to improve is through one's own efforts. They also realize that the greatest fear of all is fear itself.

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[35]Gerald S. Craig, Science for the Elementary School Teacher (Chicago: Ginn and Company, 1947), p. 20.

Freeman and Dowling report that elementary teachers may be aided in becoming skilled science teachers if they decide upon their problems and possess the desire to improve. It is necessary to decide which problems can be solved personally and which require the assistance of other people. Teachers must be flexible and willing to be learners. They must have humbleness, inquisitiveness, industry, critical judgment, and other desirable attributes of a good learner. They must vigorously and enthusiastically attack their problems by seeking assistance from all available sources. Teachers should share their findings with their associates.[36]

Even though an elementary teacher may have a few fears about teaching science, these fears should disappear when she recognizes that an elementary teacher need not be a specialist in any one field of science. Glenn Blough sets forth the following points to bolster the frightened teacher:

1. Almost all girls and boys like science.
2. They don't expect you to know all the answers to their questions.
3. Science in the elementary school should be kept very simple.
4. You can learn with the children.
5. It is no harder to teach science than it is to teach social studies or language arts or anything else.

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[36]Freeman, Dowling, Lacy, and Tippett, op. cit., pp. 21-22.

6. Science experiences often work in naturally with the general learning going on in a room.

7. The first time over the ground is the hardest; a little practice in teaching science will bolster one's courage.[37]

After an elementary teacher has lost the first fears concerning the teaching of science, Blough and Huggett suggest that the teacher do the following:

1. Read science material both on the children's level and on your own. Keep them on your desk for ready reference.

2. Do some of the "things to do" or "going to see" ideas that are suggested by the books. After the start is made, you may be surprised at your own enthusiasm.

3. Do some of the experiments yourself. They are not difficult, and many of them are very interesting.

4. Find a junior-high-school science teacher and ask his help. It will do each of you good to know what the other is doing.

5. Find out whether your state, county or city has a course of study or bulletin on the teaching of science. If not, write to other states and cities and obtain their bulletin or course of study.

6. Be sure to order the teacher's manuals that go with the textbook used in your school.

7. Watch current periodicals and other publications for articles about science teaching.

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[37]Glenn O. Blough and Albert J. Huggett, Elementary School Science and How to Teach It (New York: The Dryden Press, 1951), p. 4.

8. Try to arrange to watch another teacher working with children and science.

9. Avail yourself of any opportunity provided in your school to attend workshops, extension courses, or other in-service projects which can better equip you to teach science.

10. Be open-minded in your approach to the teaching of science.[38]

Blough and Blackwood add a few more suggestions to the preceding list for the fearless and ambitious elementary science teacher.

1. Approach the teaching of science with confidence not with awe. It's not as unusual as you think.

2. Don't expect to know the answers to all of the science questions children ask you. If you plan to wait until you do, you'll never begin teaching science. Teachers tell children too much anyway.

3. Don't feel too handicapped because you lack materials. Children can bring from home almost everything you actually need. What they can't produce, you can get at the dime or hardware store, borrow from the school janitor, or let the children make. Expensive complicated apparatus is worse than useless in the elementary science class.

4. Talk to other grade teachers about what things they have found successful, and be ready to share your experiences with them.

5. Start your science by teaching a unit with which you feel most at home.

6. Let pupils experiment. It's one way children

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[38] *Ibid.*, p. 5.

> learn and they like it. Use some of the more apt pupils in your class to help gather materials and set up the experiments.[39]

Julia Wetherington adds to the previous lists a few more ways by which the elementary teacher can feel more secure in science teaching.

1. Know something of the home life experiences of the child, as you can.
2. Make field trips with other teachers, or alone.
3. Add pictures and articles to the school library. Use them.
4. Preview many films and filmstrips on the same subject.
5. Join the National Science Teachers' Association.
6. Alert yourself to the use of scientific attitudes.[40]

The belief that fear tension is released when the teacher and children plan and explore together should give a secure feeling to any classroom teacher who has doubts concerning his abilities for teaching science.

The elementary school principal aids in the teaching of science. Many elementary principals have had few oppor-

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[39]Glenn O. Blough and Paul E. Blackwood, Teaching Elementary Science (Washington: U. S. Government Printing Office, 1954), pp. 10-11.

[40]Julia Wetherington and Committee, Science for the Elementary School (Raleigh: State Dept. of Public Instruction, 1953), p. 14.

tunities to become acquainted with science that is meaningful and profitable for children. They have not seen its possibilities in the daily school program; therefore, they have not developed a real enthusiasm for it. Since elementary teachers are sometimes in the same position, the science program generally is lagging in the elementary schools of the United States. As Blough points out, in schools where teachers and principals are equipped to teach and administer science the program is good. If this is untrue, not enough science can be found in the school program to evaluate it.[41]

Without a doubt there cannot be a good science program unless both principal and teacher desire it to be so. It is not the function of the principal to develop a science curriculum to be handed out to teachers to follow. It is the role of the principal as a leader of teachers, to work with them in developing a science program based upon the needs of the children under his supervision. The principal and the teacher should attempt to keep the science program flexible enough to meet the needs of boys and girls.

Every principal with a sincere desire to assist the children under his supervision in having a worthwhile science

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[41]Glenn O. Blough, "The Principal and the Science Program," <u>The National Elementary Principal</u>, Vol. 35 (April, 1956), 34.

program may do so by aiding the teachers who have direct influence upon the science potentialities of boys and girls. The following suggestions for accomplishing this have been enumerated by Blough.

1. The principal should understand the attitudes and limitations of his teachers.

2. He should encourage the teachers to try science teaching and should not expect perfect performances in the first trials.

3. He should be helpful in providing a minimum amount of simple equipment and supplies. This equipment should have easy availability.

4. Opportunities should be provided to assist teachers in learning how to use materials and equipment.

5. He should try to provide an outline that is definite enough to be helpful, flexible enough to permit some originality on the part of teachers and pupils. (This could be a course of study or resource unit).

6. Make the materials and books easily available and help or provide help in use of books and other materials.

7. Educate himself in the science area of the curriculum.[42]

An alert principal should be a source of ideas and suggestions for pupil activities in science. He might encourage teachers to make exhibits of science experiments in

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[42] *Ibid.*, p. 35.

a museum case placed in a strategic part of the school. He can see that services of older children may be used by teachers of younger children in demonstrations and cleaning equipment. He can help in planning science trips, setting up animal feeding stations, and showing motion pictures.

The principal, with adequate office assistance, could channel pictures, charts, posters and other materials that pass over his desk to the classroom teacher. The professional literature of the principal, containing science teaching suggestions, might be made available to the teacher. The principal who has office help, could assist in letter writing in ordering materials for use in the classroom.

In the following quotation pertaining to the elementary science program, Blough restates an old saying. "As the principal is, so is the school," is not idle chatter, especially when it comes to the science program in the elementary school.[43]

Some essential factors in good science teaching. It is practically impossible to carry on a "find out for yourself" approach in science education without a minimum amount of space, supplies and equipment. It is not necessary to have a complete laboratory in which to teach science.

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[43] *Ibid.*, p. 34.

Much valuable science material and equipment may already be in the classroom, in the home, in the school storeroom or in a boy's pocket. Very often they can be borrowed from various community sources and brought to school for a science period.

One essential factor which aids children in learning science is a suitably-arranged classroom. This classroom needs to be arranged in such a manner that real investigating, discovering and inventing can take place. All teachers are aware that the genius of the best modern architect will never produce the "ideal" classroom. This classroom must grow out of the purposes of the children and the teacher who use it. Room arrangements and facilities vary widely in their usefulness. A classroom environment that is both flexible and functional can be created by using, to the best advantage, those possibilities the room affords. What is an ideal classroom? The writer presents the following description of the ideal classroom as described by Burnett.

> The ideal classroom is very large. It has seats that can be easily moved to form a large circle, rearranged for small working groups, or placed in rows when a more formal seating is desirable, as when slides or films are projected on a screen or teacher or student demonstrations and presentations are made. The ideal classroom has several workbenches or tables. It has space where hand tools such as saw, files, tin shears,

> hammers and pliers may be kept in good order and easily accessible for use. It has storage space for wood, nails, bolts, screws, tin, paper, and string. It has storage cabinets where specimens, equipment, exhibit material and working materials may be stored until they are needed. Some of these cabinets have locks so that materials dangerous to children or easily broken by tiny fingers may be kept secure. Some of these are low cabinets so that children may easily get materials as they need them. The ideal classroom has a sink with running water, a Bunsen burner, and facilities for cleaning up. It has open shelves and tables for housing exhibits and adequate bulletin board space for the display of children's materials and items of general interest.[44]

All classroom teachers hope for this ideal room but are aware that it is rare. Consequently, they are encouraged by the fact that most classrooms can be modified to approach the ideal standards in all respects except size.

A sample of other essential factors that should be available in an intermediate classroom is listed by Blough and Blackwood. This list includes suggested items most frequently used in teaching science in the intermediate grades.

I. Electricity and Magnetism

1. Piece of lodestone
2. Pair of bar magnets
3. Large horseshoe magnet
4. U-magnet
5. Shaker of iron filings
6. Knitting needles
7. Magnetic needle

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[44] Burnett, *op. cit.*, pp. 136-137.

8. Magnetic compass
9. Glass friction rod
10. Hard rubber friction rod
11. Electric lamps and sockets
12. Fur for rubbing friction rods
13. Colored pith balls for static electricity
14. Demonstration electric motor
15. Telephone receiver
16. Telephone transmitter
17. Dry cells
18. Insulated copper wire
19. Electric push buttons
20. Electric bell

II. Air and Weather

1. Glass barometer tube with well and medicine dropper for filling with mercury
2. Mercury
3. Tin cup

III. Sound and Light

1. Tuning fork
2. Prism
3. Concave and convex mirror
4. Color rotator to show the results of mixing colors
5. Reading glass[45]

No suggested list of essential science materials is complete without mention of books. Every intermediate grade should possess or have access to reference books, library books, text books, magazines and bulletins.

There should be, in the teacher's desk or file, a list of available audio-visual aids and community resources.

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[45]Blough and Blackwood, _op_. _cit_., p. 33.

The teacher and pupils should have a growing picture and poster file that is easily accessible when needed.

Current practices in elementary science teaching. E. T. McSwain and H. G. Shane list six practices in teaching elementary science that are employed in grades one through six.

1. Incidental science conversations are used in schools where little heed is given to the developmental values of elementary science. The teacher takes an occasional "time out" to discuss some current scientific topic.

2. Spontaneous science learnings are often stimulated by a dramatic and meaningful happening in the children's immediate environment. While spontaneous science work cannot be planned in advance, it may lead to creatively planned investigations by a group of children if the teacher recognizes and encourages these developmentally desirable activities.

3. Science as a reading lesson is being used in classrooms since so many well written and attractively illustrated books have been published in recent years. Experimentation, planning, and discovering are all kept to a minimum when reading skills are emphasized for their own sake.

4. The course of study is used in some school systems. The variety and scope of these courses of study in science are great. One promising variation is the handbook approach, in which the course of study is not definitely prescribed. Instead, a large number of learnings are suggested without regard to grade level and help is given to teachers who feel inadequate in science by providing descriptions of materials and experimental procedures which might be used in the classroom.

5. Correlated science teaching which systematically relates the subject matter of science to the content of other fields is finding a place in the elementary school program.

6. Science-centered enterprises involve cooperatively planned work which has its focus on a broad scientific topic. Usually this type of activity lasts for a considerable time and subject matter from other fields is taught with regard to its relationship to the science experiences which are planned.[46]

Which practice is the fourth-grade teacher going to use? Without a doubt, circumstances help to determine which practice is most appropriate in a particular classroom situation.

Burnett describes the different patterns in which the curriculum of the elementary school may be organized. He states that the two most common patterns are often called the "subject matter" curriculum and the "areas-of-living" curriculum. There are many variations and deviations from these patterns. He is certain that science can contribute to the learning experiences of children under any curriculum organization. Burnett states further that some of the problems that have plagued curriculum workers and teachers attempting to improve their instruction are as follows:

1. What concepts, understandings, skills and abilities may be expected of children at various age and maturity levels?

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[46]E. T. McSwain and Harold G. Shane, Evaluation and the Elementary Curriculum (New York: Henry Holt and Company, 1951), pp. 235-243.

2. What experiences should be provided at each level?
3. When is the best time to introduce this or that instruction or learning area?[47]

The subject matter curriculum is the traditional pattern for the curriculum of the elementary school. Burnett believes one of the reasons this curriculum is used so widely is because the problems of scope and sequence in a subject are more easily handled by this traditional approach. Another virtue to this approach is the simplicity of it. The job is well defined. Each teacher has a certain content to cover and a certain set of skills to develop. The subject matter curriculum in elementary science is defended on the ground that a subject such as science has a certain internal logic and structure. It is held that the child will develop skills, social abilities and total personality through progressively mastering the racial heritage of mankind through studying the organized disciplines or subjects.

In the areas-of-living curriculum, all subject matter sequences and logically organized content is set aside in favor of educational experiences in the major areas of life activities in which children are engaging or soon will be engaging as individuals and social participants in a democracy.

What about the problems of scope and sequence? What

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[47] Burnett, op. cit., pp. 111-112.

experience should be offered at this level and what at that level? To answer the foregoing questions the advocates of the areas-of-living curriculum have chosen as areas for coverage at each grade level certain "major functions of social life." The problem of sequence is usually solved through proposing "centers of interest" presumably appropriate for each grade level.

Other patterns have been developed in different parts of the United States in order to meet the pressing problems created by the subject matter curriculum and those created by the areas-of-living pattern. These patterns are known as the "cultural epoch" and the "child-centered" approach. Out of all of these approaches there has grown a belief that the curriculum of the common schools should focus attention on the kinds of total experience that children should have as total human personalities, rather than upon the subjects they should study.[48]

Burnett points out that curriculum makers have found the following criteria for selecting science experiences and content.

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[48]*Ibid.*, pp. 112-117.

The most common criteria for the selection of experiences and content now in use in curriculum development throughout the country are (1) the needs of children; (2) the basic social processes which society must carry on; and (3) the values that are basic to democracy and to the furtherance of individual and group life in the world today. Flexibility has become almost a watchword, and problems of scope and sequence have receded into the background as experience has shown them to be generally unimportant in programs that are frankly designed to help each child develop optimally as an individual and a contributing member of a group.[49]

Characteristics of the present-day elementary science program. One of the outstanding characteristics of modern science, as stated by Craig, is that it does not view knowledge as absolute. Any statement of science can be challenged, revised or refuted with suitable data. There is no room for dogmatic attitudes. There can be no dictator for science. Science is an active, dynamic field, constantly demanding willingness to make new observations, to repeat experiments, to consider new facts and to challenge earlier conclusions. It is far from a finished subject. As a result of continuous study, all areas of science are undergoing change. Since man is continuously in the process of making new discoveries and revising his information, he cannot always have absolute certainty. This means that a fact is not taught as if it is

[49] Ibid., p. 117.

true for all times. It also implies that we cannot at any given time teach a child all the truth about any single subject. A child's ideas gained from science can be accurate as far as they go, but as a child proceeds through the school his knowledge of science, as of any other subject, increases in amount and detail.[50] As he continues his studies, he gains broader and deeper insights and understandings. To promote such learning, teaching methods must be such that development of scientific attitudes is encouraged.

Robert Stollberg says that "problem-solving" is "the precious gem of science teaching." He also refers to this method of teaching as the "can-find-out-ability" of boys and girls and continues to identify it as a general type of human behavior. It includes an assortment of skills and attitudes and habits. Among them are skills such as asking meaningful questions, using indices effectively, reading with speed and comprehension, observing carefully, recognizing problem situations and inventing and testing tentative solutions for them. Included in this list also are the habits of being curious, thorough and careful. The above is

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[50]Gerald S. Craig and Beatrice Davis Hurley, Discovering With Science, Teacher's Manual (Chicago: Ginn and Co., 1955), pp. 11-13.

only a suggestive list of the ingredients of problem-solving.[51]

Another characteristic of good science-teaching in the elementary school is the use of the "scientific method." What is this method of teaching? Craig points out that in a real sense it is a method of honesty, and that neither teacher nor child should be penalized in any way for being honest. The learner should never be humiliated for the admission of ignorance.[52]

A scientific attitude is often listed as a characteristic that all teachers of science should develop in boys and girls. A group of elementary teachers in Decatur, Illinois, describes scientific attitude as follows:

1. A curiosity to know about one's environment.
2. The belief that truth itself never changes, but that our ideas of what is truth change as we gain more and more knowledge.
3. A determination not to base final conclusions on one or a few observations, but to work as long as may be necessary in order to secure an answer to a problem.
4. The desire to do one's own observing and experimenting but a willingness to use the results of other scientists' work.

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[51]Robert Stollberg, "Problem Solving," _The Science Teacher_, Vol. 23 (September, 1956), 228.

[52]Craig, _op. cit._, p. 13.

5. An unwillingness to accept as facts any statements that are not supported by convincing proof.

6. The determination not to believe in superstions of any sort.

7. The determination to be careful and accurate in all one's observation.[53]

Maxine Dunfee and Julian Greenlee contribute to the list the following basic characteristics that every worthwhile elementary science program should have or acquire.

> Science education in a good elementary school should be a definite, planned part of the school program. It may not be given special attention every day; it may not always appear at a particular time in the day's schedule. But the science is there, carefully planned to permeate the program, to help children come to understand those basic science principles that are essential to living in today's world. The science content and procedures for teaching it are selected in terms of the needs, interests and developmental level of the children who are being taught. The science program is likewise influenced by the particular environment in which it is taking place.[54]

<u>Activities used in teaching elementary science</u>. It is apparent to the writer, that there is no one right method

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[53]Elementary School Science Committee, <u>Tentative Plans for Teaching Elementary School Science</u>, (Decatur: Decatur Public Schools, 1948), p. 4.

[54]Maxine Dunfee and Julian Greenlee, <u>Elementary School Science: Research, Theory and Practice</u> (Washington, D. C., Association for Supervision and Curriculum Development, 1957), p. 26.

of organizing experiences for the elementary school science program. It seems sensible to use a combination of all methods that are described in the literature.

J. R. Shoptaugh is of the opinion that the teaching of science in the intermediate grades should not be haphazard, neither should it be cut and dried. There should be a plan for the science that is taught throughout the year with plenty of time allowed for the unexpected and spontaneous things that may come up. It is wise to proceed slowly while teaching science. Children as well as adults must have time to live with an idea. Progress in understanding does not come from an accumulation of ideas but through their gradual unfolding in the minds of children.[55]

Craig feels that teachers should provide learning opportunities which allow time for a learning element to be absorbed, to be thought over and to become acceptable in a real sense. It is important that children be given opportunities to toss an idea about for the thinking of a group. Sometimes an idea can be tested through observation, simple experimentation, or it can be checked against authoritative sources. It is wise for a teacher to permit children

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[55] J. R. Shoptaugh, "Teaching Science in the Elementary School," Elementary School Journal, Vol. 52 (April, 1952), 469.

to participate in the thinking and guiding of the teaching and learning.[56]

A few activities found very useful in teaching elementary science are listed by Craig[57] as follows:

1. Discussion should be used because it serve to clarify the problem. It serves to bring children's experiences pertaining to the problem into clearer light. It aids in planning the method of study as well as the evaluation of it.

2. Experiment may be used to clarify the problem, for it aids the children to visualize certain natural forces in operation. It may be used to free children from superstition. It may aid in finding the solution to problems. Experiments should be accompanied by discussion and reading.

3. The Excursion does aid children to study a phenomenon in its natural setting. In the end, conclusions arrived at through excursions should be checked against authoritative material.

4. Reading occupies a large place in science. It may serve as a means of developing leads, assist in making

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[56]Craig, *op. cit.*, p. 29.

[57]*Ibid.*, pp. 36-38.

the learner acquainted with a phenomenon to be studied, or it may be utilized to give him additional illustrative material. The learner must depend in part upon the reading of authoritative material for reliable information. Information gained from other types of activities must be checked by reading authoritative materials.

The writer believes experimenting is an activity that adds a great deal of enrichment to the elementary science lesson. She has found the following suggestions offered by Blough and Huggett, particularly helpful in planning and carrying on experimentation in her science teaching:

1. Keep the experiment simple.
2. Perform experiments in such a manner as to cause children to think. If you plan to tell children the answer or let them read the answer, why bother with an experiment.
3. Plan experiments exactly and carefully, and let pupils do as much of the planning as possible.
4. Don't let pupils make sweeping generalizations from one little experiment.
5. Let pupils themselves perform the experiment. Experiments ought to be simple enough and safe enough for them to do.
6. Teachers should often ask "Can anyone think of something we can try to help us with this problem?" Children should originate some experiments.
7. Experimenting should have a specific purpose that should be understood by all.

8. It is not always necessary or desirable to have records of experiments.[58]

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[58] Blough and Huggett, *op. cit.*, pp. 27-28.

CHAPTER IV

A PART OF A FOURTH-GRADE SCIENCE PROGRAM

The writer believes a planned outline of some form should be available while teaching science. If there is no plan, there may be no definite or clear-cut goals to be sought. The writer is aware that many science text-books, courses of study, and outlines should be examined for ideas concerning objectives to be sought and for information concerning science experiences and content to be used.

At the time this study was made, the writer was teaching a fourth grade. This particular fourth grade became interested in the study of rocks from the playground and surrounding area. Immediately following this study it was very easy to start a study of magnetism by presenting a lodestone. Here was a rock from a faraway area. It was different because it would pick up small objects such as paper clips, tacks and pins. The writer related to the class the information she had learned from reading about the first magnet or leadstone, as it was sometimes called. Plans were made for members of the class to read and find out more about the lodestone and to tell their findings to the class on the following day. Children volunteered to bring magnets to school. A pair of bar magnets was located in the science kit. The next lesson was pertaining to the shapes of magnets, the materials they are made of and the materials attracted to magnets. Some iron filings were brought to the classroom. A piece of glass and a piece of cardboard were placed on a table. The iron filings were placed on the glass and cardboard. Immediately someone discovered that the magnet would attract through other materials. On the following day the writer helped the class discover the polarity of magnets. It was interesting to learn that one pole of a swinging magnet will pull toward one pole of another magnet while it will turn away from the opposite pole. A few members of the class wondered if magnets had any other uses besides those they had discovered. Research was necessary. Reports were made. A movie entitled "Michael and His Magnets" was shown. The writer, having become a fearless science teacher, made an electromagnet. This magnet could pick up iron filings and drop them if the electric wire was detached from the dry cell.

As the study proceeded, it was found that the magnets and other materials used in the experiments should be left where the children could use them during many periods of the day. Many experiments were tried, both those planned by the class and those taken from text-books and other sources.

From the text called Discovering Our World, the following specific concepts for teaching a unit titled, What Can Magnets Do, were used as part of a planned science sequence.

1. Magnets attract iron and steel.
2. The force of a magnet will pass through many things.
3. The places where the force is strongest in a magnet are called poles.
4. Every magnet has two poles, a north pole and a south pole.
5. A freely swinging magnet will point in a north-and-south direction.
6. Like poles of magnets repel each other; unlike poles attract each other.
7. The earth acts like a huge magnet with north and south magnetic poles.
8. The needle of a compass does not point exactly north because the geographic poles and the magnetic poles are not in the same places.[59]

A course of study titled A Source Book of Science Experiences for Elementary School Children was used as a source for several other specific concepts. These concepts are listed as follows:

1. Magnets are of different shapes.
2. Most magnets are made of steel, but some are made of iron or alnico (aluminum, nickel and cobalt).
3. Lodestone is a magnet found in the earth.
4. The magnetic field of force is the space around the magnet in which it can attract iron and steel.
5. A magnet whose poles are known can be used to find the poles of a magnet on which they are not marked.

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[59]Wilbur L. Beauchamp, Mary M. Williams, and Glenn O. Blough, Discovering Our World, Book I, (Chicago: Scott, Foresman and Company, 1952), p. 63.

6. A compass is used to tell direction on the earth.
7. Every wire carrying an electric current becomes a magnet.
8. The exact cause of magnetism is not known.
9. Iron or steel is made up of tiny particles called molecules, each one of which is a little magnet with a north pole and a south pole.
10. An electromagnet is a temporary magnet. It is only a magnet when electricity is flowing through the wire.
11. Man makes many uses of electromagnets.[60]

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[60]Louisville Public Schools, A Source Book of Science Experiences for Elementary School Children, (Louisville: Public Schools, September, 1954), p. 379.

CHAPTER V

SUMMARY

It is possible for a teacher to enrich a science program if she becomes prepared to teach science in the elementary school. The teacher should acquire a knowledge of her science teaching problems and possess a desire to improve in science teaching. It is very important that the teacher keep up with new ways of doing things. She must keep up with new devices on the market, new words, the news, books for young people and instructive programs on radio and television. The teacher in the elementary school should adopt an enthusiastic and inquisitive point-of-view concerning the many science materials that may be found in the home, school, library, museum, dime-store, department-store, playground, forest preserve and scientific supply house.

It is necessary for the teacher to take a good look at the elementary school science program to note the kind of information children are required to learn. Is it too specialized? Is it too general? Does it stimulate the child's interest? Does it aid the child in understanding his world? Does it assist the child in becoming an alert, inquisitive, resourceful and well-meaning member of society? Since science has its importance in elementary education only as it serves boys and girls and through them the democracies of which they are a part, it is very important that a science program assist children to accept change. Nothing remains fixed, even modes of transportation, insects and mountains are subject to change.

Today's classroom teacher has a much better chance of improving science teaching with information gained from research than did the classroom teacher of twenty-five years ago. The teacher should try to keep an open mind concerning methods to be used while teaching science in the elementary school. She must keep in mind that science involves observation, and observation is enriched by experiment and the use of science equipment. She should also remember that the reason for observation is the discovery of facts which can often be used in solving problems or in the verification of previously discovered facts.

It is very important that the classroom teacher go to the child-development specialist for aid in becoming better acquainted with the behavior patterns of the boys and girls in her classroom.

The classroom teacher, more than any other person on the school staff, determines the quality of the educative experiences provided the children in the classroom. The quality of the science program in the elementary school classroom will become enriched when the classroom teacher becomes fearless, stops making excuses, adopts a learner's attitude and starts teaching more science.

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