A MODEL FOR THE DEVELOPMENT AND IMPLEMENTATION OF A SCIENCE CURRICULUM IN THE ELEMENTARY SCHOOLS OF IRAN

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ABSTRACT

A MODEL FOR THE DEVELOPMENT AND IMPLEMENTATION OF A SCIENCE CURRICULUM IN THE ELEMENTARY SCHOOLS OF IRAN

By

Morteza-Rahimi-Naini

The main purpose of this study was to construct a model for the development and implementation of a science curriculum in the elementary schools of Iran. The need for the study was indicated by the government's continued plans and efforts to improve educational opportunities, the present elementary science curriculum and the methods employed in teaching, and the inherent potential which science instruction has for developing in children desirable patterns of thinking and acting. The model represents a theoretical scheme which was constructed from hypothetical reasoning and empirical information. The study was designed to collect relevant information and to offer suggestions and recommendations with respect to the component parts of the model which were: science curriculum--objectives and content, teaching procedures, instructional materials including audiovisual aids, pupil evaluation, teacher training, and model evaluation. It was assumed that the model was by design adaptable to and functional within the present organizational pattern of elementary education under the administration of the Ministry of Education in Iran.

As a background for constructing the model, a review of the science curriculum developments in the United States was made and attention was also given to the nature of science, to modern concepts of learning and teaching, and to the application of such concepts to the development of textual materials which would incorporate both the products and processes of science. Curriculum development, as used in the study, included all the tasks involved in making decisions relative to planned science experiences and to methods of instruction by which the objectives of the science curriculum might be attained. The study presented a relative detailed discussion and rationale for each of the component features of the model with accompanying recommendations for each interrelated component. The model included recommendations as to organizational patterns of operation, to administrative responsibilities, and to the implementation of the curriculum.

The basic unit of the model was the establishment of a Curriculum Development Committee as an integral body under the administration of the Ministry of Education. This committee, to be composed of regular staff members and selected scientists, science educators, elementary teachers, supervisors, administrators, and specialists in evaluation, curriculum, and educational psychology, would have the responsibility for the decision making and actual work relative to the recommendations made for the component features of the model. Sub-committees of the Curriculum Development Committee would have the responsibility for developing the selected subject matter content and learning exercises for the selected subject areas at each grade level one through five. It was recommended that in developing the learning exercises that the exercises be designed for inquiry or discovery learning by the pupils. These exercises should involve the direct observing and handling of objects and afford the pupils practice in the processes of science, such as classifying, predicting, formulating hypotheses, testing or experimenting, and drawing valid conclusions.

The model provided that the tasks of the sub-committee be undertaken in designated writing sessions where the members would be assembled together in order to coordinate all aspects of their work. The development of teacher manuals for each area at each grade level was considered a necessity for effective implementation of the science curriculum as were the recommendations for teacher training through inservice and/or workshop experiences. Components of the model which were specifically related to already established departments in the Ministry of Education would be implemented by the concerned departments.

The model proposed that the science curriculum, as developed by the sub-committees, would be tried out in "trial schools." Evaluation of the model with special attention to the achievement of pupils and teacher reaction in the "trial schools" would be the responsibility of an evaluation team appointed by the Ministry of Education. After such an evaluation, final editions of the textual materials would be made.

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By

Morteza-Rahimi-Naini

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CHAPTER I

INTRODUCTION

The literature reveals many reasons for including science instruction in the elementary and secondary school programs. One reason is that scientific knowledge provides the facts and concepts inherent in an understanding of the nature of physical and biological phenomena. Another reason is that the methods used to gain scientific information include processes and attitudes which when practiced can influence one's overall ways of living. These reasons provide the basis for the implication that instruction in such knowledge and ways of acting could constitute one of the educational approaches by which progress might be made in many aspects of human living.

Since this study was limited to Iran, it is worth noting that the government of Iran, including the various ministries responsible for educational programs, has given, for a number of years, attention to the problems inherent in the improvement of educational, social, economic, industrial, and living conditions in the country. The attention given these problems and the implementation of some of the plans to bring about general improvements in these conditions have produced noticeable results. Improvements have occurred in communication and transportation facilities, in agriculture practices, in the modernization of some industries, such as oil, copper, and iron, and in educational opportunities. The need for continued improvement in the utilization of the country's resources is still a vital concern of the government. During the past decade, the government has increased its efforts to plan and to implement educational programs that will educate its citizens for more productive and satisfying living in the modern world. Thus, this study may be of particular interest to the government of Iran. The study should be of interest to the reader who desires to familiarize himself with some of the educational problems in Iran and should also be of value to anyone who is attempting to develop a model for science instruction in the elementary schools in a country with similar problems to those in Iran.

Purpose of the study. The main purpose of this study was to construct a model for the development and implementation of a science curriculum in the elementary schools of Iran. The model was designed to include relevant information and recommendations regarding educational needs and practices which should be considered in developing such a curriculum.

Information relevant to the design included consideration of some of the factors affecting social, cultural, and economic conditions in Iran. As one source of information for the preparation of the model, the author reviewed a number of the new science curriculum programs which had been developed in the United States of America during the past ten years. This review included such things as the nature of science, the objectives of science instruction, and the methods for teaching science. Attention was also given to selected philosophical and psychological aspects of learning and to child growth and development. The rationale and recommendations represent the author's synthesis of ideas which he considers to be meaningful and constructive in relation to science instruction and in the long run to the overall improvement of educational opportunities in Iran.

General comments relative to educational needs. The need for increased overall educational opportunities in Iran is very great. The writer is particularly aware of these needs as he has been an active teacher in Iran for nineteen years. His experiences include teaching and supervision in both rural and urban elementary schools. He has also been involved in the preparation of elementary teachers in institutions for teacher training. From personal observations, there is no question as to the need for improvements in school offerings and instructional materials and teaching procedures.

The educational programs of a country are the results of many interacting factors and conditions. Historical, social, cultural, philosophical, and economic conditions are significant factors in determining the nature of the educational goals and opportunities. These are things that need some consideration in order to develop a curriculum that will meet the needs of a particular country. Taba says

> To evolve a theory of curriculum development and a method of thinking about it, one needs to ask what the demands and requirements of culture and society are, both for the present and for the future. Curriculum is, after all, a way of preparing young people to participate as productive members of our culture. Not all cultures require the same kinds of knowledge. Nor does the same culture need the same kinds of capacities and skills, intellectual or otherwise, at all times.[1]

The task of treating in detail the social, cultural, philosophical, and economic conditions and/or problems of a developing country such as Iran is beyond the scope of this study. It was deemed significant to discuss briefly some of the problems facing those who are concerned with the overall improvement of education in Iran and with science instruction at the elementary level in particular.

With respect to the problems to be faced by a developing country, it is significant to note that the present government of Iran, a constitutional hereditary monarchy, has been concerned for many years with the means and ways to improve the economic and living conditions in the country including educational opportunities. This concern is evidenced by the increased amount of money allocated in recent plans for social and economic improvements in the country. Chapter II presents brief reviews of these plans since 1949. It is also noteworthy that the Ministry of Education in recognition of the need for improvements at both the elementary and secondary levels initiated in 1966 a reorganization of the schools. In view of governmental interest in education, one may

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[1]Hilda Taba, Curriculum Development. Theory and Practice (New York: Harcourt, Brace and World, Inc., 1962), p. 10.

assume that the time may be ripe for consideration of a model designed to improve science instruction at the elementary level. The adoption of such a model should contribute to marked improvement in facilities for science instruction, in the nature of the science content to be taught, and in the methods of teaching science.

The problems which indicate the need for studies in ways to improve the educational opportunities in Iran are many and the author recognizes that there are no simple answers. The attention given the following conditions and/or factors is illustrative of some of the problems which indicate the need for educational improvements in Iran.

Illiteracy. In regards to the total education situation in Iran, illiteracy is one of the most pressing problems. The government has recognized this problem and efforts have been made to attempt to solve the problem. However, even with the efforts which have been made to decrease illiteracy in Iran, illiteracy is still one of the country's greatest drawbacks in achieving the government's goals for better economic, social, and healthful conditions throughout the country. In urban areas, 49.6 percent of the population over seven years of age, according to the 1966 census, was illiterate and in rural areas the percentage of illiteracy was 84.9 percent.[2] While these percentages have been reduced

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[2]Plan Organization, Iran Statistics Centre, Statistical Year Book of 1971 of the Country, Consecutive Number 326, 1973 (Esfand, 1351), p. 103, "In Persian." Hereafter this designation "In Persian" will be used to indicate that the reference cited was printed in the Persian language.

somewhat since that time, the problem is still largely unresolved. The lack of school facilities, such as inadequate buildings and instructional materials, scarcity of qualified teachers, and general apathy on the part of a large percentage of the population contribute to the problems and indicate the need for both general and specific educational improvements.

While the writer does not contend that the need for science instruction is necessarily more important in reducing illiteracy or in achieving certain of the government's overall goals for the country, he does believe that the need for emphasis on science is particularly evidenced in the general populations' lack of knowledge and understanding of the facts and concepts which have practical applications in productive and healthful living. This need is also evidenced in the actions of the many individuals who hold to fatalistic and superstitious beliefs.

Fatalism and Superstitions. Fatalistic concepts and superstitious beliefs influence the lives of most of the individuals in the illiterate population. Illness, poverty, drought, and one's position in life are accepted by most of the uneducated as a matter of fact. The acceptance of fatalistic concepts may account for the general apathy exhibited by many uneducated individuals. According to Hanson and Brembeck,

> This fatalism has removed the person from participating in his own fate. The forces which determine his fate seem

> so far beyond understanding and control that it is easy for a person to withdraw and feel no responsibility for self.[3]

Particularly in some rural areas, diseases are looked upon as due to "evil spirits" and various rituals are practiced as a means of removing the "spirits" from the body of those that are ill. The general population in these areas have little, if any, knowledge as to the causes of disease and to healthful living conditions.

There is, therefore, a need for a science curriculum that will provide children with the information and experiences by which they may acquire an understanding of the order in the universe that permits one to recognize cause and effect relationships. Such an understanding should lessen actions based on superstitious beliefs and provide individuals with a basis for acquiring new beliefs which are not based on such things as fear, lack of knowledge, and traditional practices which have no scientific validity.

Other attitudinal factors. Fatalism and superstitious beliefs are only examples of obvious factors that need to be dealt with in developing an educated citizenry. There is need for an educational program that will increase an individual's self-confidence and his own feeling of worthwhileness. New attitudes need to be developed toward the significance and value of education including the attitude toward manual labor. Education needs to be viewed as a necessity for individual and societal development.

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[3] John W. Hanson and Cole S. Brembeck, Education and the Development of Nations (New York: Holt, Rinehart and Winston, 1966), p. 286.

Vocational endeavors that involve manual work should be considered significant and worthwhile and not something menial or below the dignity of others. There is a need for education which will motivate individuals to want to achieve, to participate actively in society, and to take care of themselves rather than being dependent on the others for their subsistence. An adequate science curriculum, if properly implemented, should contribute not only to the factual knowledge of children, but should also contribute to the development of the positive attitudes cited above and to positive attitudes toward the wise use and management of natural resources, the value of education for meeting social and economic changes, and the improvement of living conditions throughout the country.

Curriculum problems--establishing educational goals and determining subject matter content. There are many things which need to be considered in establishing goals and subject matter content for a modern educational program which includes science as an integral part of the program. One of the factors which should be considered is the immediate and long term needs of the people that live in widely different environmental situations such as occur in Iran. This factor is very significant in the kinds of experiences that individuals should have in preparing them to become effective and productive participants in the area in which they live. Some other factors that need consideration, if goals and content are to be meaningful, useful, and attainable, are the varying life styles, means for making a living, and the customs that are unique to the individuals in different parts of the country. In addition to these factors, such things as student interests, their previous experiences, their maturation and their capacities need to be taken into account when decisions are to be made relative to the selection of goals, content, and instructional techniques at specific grade levels.

A very significant concept inherent in the selection of goals and content is that goals and content determine the quality of an educational program. In this respect, it is to be noted that many educators feel that the most desirable educational program is one that provides individuals with useful and meaningful facts, concepts, and conceptual schemes relative to the various disciplines studied and that contributes to the development of behavioral patterns which will better prepare an individual to meet his own needs and the socio-economic needs of the society in which he resides. Beeby indicates that there is a significant relationship between the quality of education and its implementation and socio-economic conditions in his contention that

> . . . , no economy will remain healthy if teachers do a shoddy job in the schools, and in most modern communities the achievement of high social purposes is closely related to economic productivity.[4]

Other conditions and/or factors which indicate the need for continued studies relative to general educational opportunities.

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[4]C. E. Beeby, The Quality of Education in Developing Countries (Cambridge, Massachusetts: Harvard University Press, 1966), p. 13.

The treatment that follows is relatively limited in coverage since the main purpose was to indicate additional conditions or factors that need to be considered in not only maintaining present educational opportunities and in making improvements, but also in developing plans for meeting future educational needs. Personal observations and national surveys indicate the very great need for modern school buildings including classrooms designed to facilitate the teaching of certain intellectuals and/or manual skills. Likewise, there is a need for adequate instructional materials and equipment. In addition to the problems associated with facilities, educational leaders are faced with changing social and economic conditions.

Iran, like most other nations, is faced with an ever increasing population which makes for new social and economic problems. Educationally some of the changes mean more facilities, more teachers, and more efforts to provide educational experiences which facilitate career determination and the training necessary for economic productivity. Another troublesome problem is the holding power of the schools which experience a high drop out rate. Rassekh reports that ". . . according to the calculation of research organization in the Ministry of Education, from one hundred students that they enter to first grade in elementary schools, presently only seventeen persons reach to the last year of secondary schools."[5] This high drop out rate may be due, at least in part,

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[5]Shahpour Rassekh, Education In Today's World (Tehran, 1971), p. 303. "In Persian."

to the failure of the schools to provide programs which are meaningful to the students. If this is the case, then there is certainly a need to develop new programs which would meet the interests and needs of the students.

Specific need for the study. The specific need for this study was based on the following three discrete but interrelated situations. The first situation had to do with the fact that the government of Iran has recognized for many years the importance of education and has taken steps to increase school facilities and to make and implement plans for increasing educational opportunities. Evidence for these statements, as cited previously, rests on the increased allocations of monies as shown in the government's socio-economic plans and the fact that a complete reorganization of the schools was initiated in 1966. These actions indicate the need for improvement in all aspects of education. In view of this recognized need for increasing general educational opportunities, the study was considered needed on the assumption that a model for developing a science curriculum for the elementary schools could make worthwhile contributions toward the achievement of general education objectives, such as decreasing illiteracy and superstitions as well as contributing to the achievement of specific science objectives.

The second situation which indicated the need for a model for developing and implementing a science curriculum for the elementary schools of Iran was the present elementary science curriculum and the methods employed in teaching. This need was based upon the author's personal knowledge and subjective judgment of the situation. A brief review of the place of science in the elementary schools, the content, and the methods used in teaching points to the need for a modern science curriculum with well defined objectives and implemented by sound psychological instructional procedures.

For many years science in the elementary schools of Iran was almost non-existent. In the textbooks that were used to teach Persian language there were selections which contained descriptive science materials. The science reading selections most often included were hygiene, living things, and topics related to the earth's surface. Pupils just read the texts. Memorization was the main objective and recitation was the method of instruction. Prior to 1966, object lessons and hygiene became a curriculum offering in the fifth and sixth grades of elementary schools. Textbooks were prepared for these grades and two hours were allocated for instruction each week. The teaching stress was on memorization and recitation.

With the reorganization of the educational program in 1966, science as an instructional area, called Science and Hygiene, was included in the elementary school curriculum. Since education in Iran is centrally controlled and directed this reorganization provided, for the first time, a defined area of science in the elementary schools throughout the country. The weekly schedule of instruction for the elementary schools allocated two hours per week for instruction in this area of science in grades one and two and three hours per week in grades three, four, and five. A series of textbooks were prepared for these five grades together with a teacher's manual. The series of texts cover three main subject matter areas. These areas are: the universe and the earth, living things, and matter and energy. The manuals for teachers were designed to give some general recommendations relative to teaching science and also to provide them with specific instructions for teaching the textbook chapter by chapter and page by page.

The reorganization of 1966 was definitely needed and the textbooks for science and the teachers' manuals were positive efforts toward improving science instruction at the elementary level. In view of the present objectives of science, such as giving children direct experiences with objects and situations and in locating problems, collecting data, formulating hypotheses, testing (by experimentation whenever possible), and drawing valid conclusions, the present texts do not provide adequate suggestions and/or activities for meeting these objectives. New texts need to be developed that are up to date and designed to give children direct experience with objects and situations whereby they may acquire knowledge relative to physical and biological phenomena and the factors that govern such phenomena. Consideration should also be given to the inclusion of scientific information that relates to the daily lives of individuals and that could furnish an understanding of the significance of science and scientific technology in the modern world. New texts should have a format which presents and organizes subject matter and activities in ways that encourages pupil motivation and the acquisition of scientific knowledge and skills through an inquiry approach. Careful attention should also be given to the kinds and to the selection of illustrations and pictures.

The manuals were designed to help teachers and they contain many general and specific directions. Efforts were made, in the manuals, to direct teachers to incorporate some sound psychological approaches in teaching, such as starting lessons with what children already know and in having children actively involved in doing things and to include experiments and field trips in their instructional procedures. Although the manuals contain such general directives as those cited above, the basic teaching plan to be followed is that of reading, questioning, and class discussion. The teaching procedure to be followed, as a general approach, is to direct the children to read certain pages in the text, then the teacher is to ask questions to bring out the concepts to be developed through pupil answers or class discussion or through teacher comments and explanations.

There can be little questions that the manuals have served to assist many teachers who may have had little or no training in science. The point that is significant today is that a modern science curriculum for its effective implementation requires teaching procedures that involve children in not only reading but that the procedures involve them with first hand experiences whereby they learn to ask meaningful questions, to make accurate observations, to classify, to make inferences and predictions, and to discover facts and interrelationships for themselves. New manuals are needed to assist teachers in implementing these and other methods of acquiring information and processes of science.

The third situation which indicated the need for this study was the attention and emphasis that educators and scientists, in various parts of the world, had given during the past ten years to the preparation of new science curricula and to methods of teaching science, and to the efforts of various curriculum projects and/or agencies to facilitate the use or adoption of the new materials for both the elementary and secondary schools in different parts of the world. This movement served to re-new an awareness of the significance of science and to re-emphasize the desirable and worthwhile objectives which could be achieved through the teaching of the processes and attitudes used by scientists. In view of these developments and in recognition of the implications that this new emphasis on science and science instruction might hold for countries interested in the improvement of their educational programs, this study was needed as one means for collecting relevant information for making suggestions and recommendations which could serve as a basis for decision making for the improvement of science instruction in the elementary schools in Iran.

Design of the study. The study was designed to collect relevant information and to offer suggestions and recommendations with respect to the interrelated components which comprised the model formulated for the study. The interrelated components are: science curriculum-objectives and content, teaching procedures, instructional materials including audiovisual aids, pupil evaluation, teacher training, and model evaluation.

Basic assumptions. In addition to the assumptions cited in various places in this thesis, the following are the basic assumptions relevant to this study. It was assumed that

1. the model was by design adaptable and functional for the improvement of elementary science instruction within the present organizational pattern of education in Iran.
2. the educational needs of nations differ and curriculum development should be based on the conditions and factors unique to a given nation.
3. in order to develop and effectively implement the model proposed in this study positive action must be taken relative to the recommendations made for each of the component features of the model.
4. the Ministry of Education would provide the financial support for the development of the model should the model be accepted as a pattern for science instruction in the elementary schools in Iran.
5. a modern elementary science curriculum should be an integral and required subject matter area in the elementary schools in Iran.

6. the development and implementation of a modern elementary science curriculum could provide a means for attaining some general educational goals and for the acquisition of useful and worthwhile scientific knowledge, understandings, skills, and attitudes.
7. an examination of science curriculum developments in the United States of America could serve as a useful source of information for curriculum development in a developing nation such as Iran.

Definition of terms. Since the meanings of or definitions of such terms or phrases as science, processes of science, inquiry or discovery learning, and learning are not subject to simple definitive statements, the treatment of these terms or phrases and similar terms and phrases has been given in the body of the thesis. The following definitions were considered useful as a basis for clarifying the rationale and nature of the comments, suggestions, and recommendations made in the study.

Model. The term model, as used in this study, was considered as an "ideal type" of structure including the processes necessary for the development and implementation of the features of the structure which may be constructed from hypothetical reasoning and/or empirical information. In this meaning, the term is a theoretical scheme.[6] As an operational definition, the term means a ". . . systematic presentation of ideas . . . ."[7]

Curriculum. Curriculum was considered ". . . as all the planned experiences (in science) provided by the school to assist pupils in attaining the designated learning outcomes to the best of their abilities."[8] In this sense, a science curriculum is the sum total of all classroom activity including objectives, content, teaching procedures, instructional materials, evaluation exercises, and the physical and pyschological climate of the classroom.

Curriculum development. In this study curriculum development was interpreted to mean all the tasks involved in making decisions, in designing and producing textual materials, learning experiences, and evaluation exercises for classroom use by pupils and teachers by which the curriculum could be effectively implemented in the classroom.

Limitations. The study is limited in that

1. it was concerned exclusively with the conditions and factors affecting education in Iran.

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[6]Modified from Talcott Parsons, "An Approach to Psychological Theory in Terms of the Theory of Action," Psychology: A Study of Science, ed., Sigmond Koch (New York: McGraw Hill, Inc., 1959), p. 695.

[7]David E. Griffiths, "Some Assumptions underlying the use of Models in Research," Educational Research: New Perspectives, eds. Jack A. Culbertson and Stephen P. Hemeley (Danvills, Ill.: The Interstate Printers and Publishers, Inc., 1963), p. 122.

[8]Ross L. Neagley and N. Dean Evans, Handbook for Effective Curriculum Development (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967), p. 2.

2. only the facts and concepts relevant to science as one of the curriculum areas in the elementary schools in Iran was considered in the study.

3. it was concerned with major recommendations relative to the component parts of the model and did not attempt to outline or to present detailed specifics, such as the actual content of a science curriculum or the exact procedures for the administration of a centrally directed curriculum. The study is further limited due to the fact that no effort was made to make suggestions as to the detailed subject matter content that would be most appropriate for specific grades.

4. it did not attempt to cover in detail the movements and developments associated with international education.

Organization of the thesis. This chapter has presented the main purpose of the study, the conditions indicating the general needs for educational improvements in Iran, and the situations relative to the specific need for the study. The basic assumptions, limitations and definitions were also covered in this chapter. Chapter II gives some descriptive features of Iran and a general review of the evolution of its educational system. A review of the literature relative to science education and the new science curriculum programs in the United States is presented in Chapter III. Chapter IV treats the nature of science and scientific inquiry and presents some psychological concepts relative to learning as background for ideas relevant to the model.

The model for the study with supporting rationale and recommendations for its establishment and implement are presented in Chapter V. Chapter VI presents a summary of the study and the recommendations according to the main components of the model.

CHAPTER II

IRAN AND ITS EDUCATIONAL SYSTEM

The first part of this chapter presents some descriptive features of Iran. The descriptive material is followed by a brief review of the government's plans for improving economic, social, industrial, agricultural, and educational conditions in the country. The last part of the chapter covers early education in Iran, some of the changes which have taken place in the organizational and instructional patterns of education, and the present elementary and secondary educational system in Iran.

Iran. Iran, known as Persia until 1935, is an ancient country. There is some archaeological evidence which supports the hypothesis that Iran was one of the first regions in which early man began to form primitive societal organizations. The organizational plan thought to have developed, along the fertile valleys, was communial living based on farming. It is estimated that Iranian history, based on legend and archaeological findings, extends as far back in time as 4,000 B.C.

The country, due in part to its geographical location and proximity to developing civilizations, had a prominant part in the early history of mankind. It was here in 550 B.C. that Cyrus, King of the Persians, was able to establish a vast empire. In the centuries that have followed, Iran and its inhabitants, have experienced repeated conflicts in which various foreign powers controlled, for a time, the destiny of the nation. The specific events of such struggles are beyond the scope of this thesis. However, it may be concluded that even with all these conquests and resulting effects, the nation has survived and has developed and maintained a distinct culture that has made many contributions to man's cumulative beliefs, knowledge, and/or creative endeavors in such fields as philosophy, religion, art, literature, and science.

Iran is a large country with a total area of 636,296 square miles.[1] The country is more than twice the size of Texas and three times the size of France. Iran is bounded on the north by the Caspian Sea and the Soviet Union, on the northwest by Turkey, on the west by Iraq, on the south by the Persian Gulf, and on the east by Pakistan and Afghanistan. The country lies between 25 and 40 degrees north latitude and 45 and 64 degrees east longitude.

A large part of the country is a high plateau bordered by high and rugged mountains. The plateau ranges from an elevation between 1,000 and 5,000 feet with some 100,000 square miles of plateau area in the central part of the country. Much of this area is desert. Due to the variations in latitude, location, and height of mountains, extreme climatic conditions occur in various parts of the country. Temperatures range from highs of 50 degrees centigrade (122 degrees fahrenheit) or more in the south and desert

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[1]The New Encyclopedia Britannica, Vol. 9 (Chicago: Helen Hemingway Benton, Publisher, 1974), p. 821.

areas to lows of minus 25 degrees centigrade (Minus 13 degrees fahrenheit) in the mountainous regions of the northwest. The rainfall in most parts of the country is about ten inches per year.

According to the last census (1966), the population of Iran was 25,789,000 and of these individuals 9,800,000 lived in large cities and towns and about 16,000,000 people were village dwellers and nomads.[2] Tehran is the largest city in the country with an estimated population of over three million people. It has been estimated that about 50 percent of the people earn their living by farming or by livestock management. There are some 3,000,000 nomadic and seminomadic people in the country. Ninety-eight percent of the population are Moslems.

Iran has great petroleum resources and produces enough coal for its own use. Mineral resources include iron ore, copper, manganese, and lead. Timber resources are limited. Food crops are mainly wheat, barley, some vegetables, and fruits. Cash crops include cotton, sugar beets, tobacco, tea, and dried fruits and nuts. The Caspian sea coast with fertile soil and adequate rainfall is one of the most productive agricultural areas.

The government of Iran, since 1906, is a constitutional hereditary monarchy. The constitution provides for legislative, executive and judiciary branches of the government. The legislature is composed of a lower house, National Assembly or Majlis, and the Senate. The number of deputies in the Majlis depends on

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[2]Ibid., p. 824.

the size of the country's population. In 1972, the number of deputies was 268. These deputies are elected by popular vote for four year terms. There are sixty members in the Senate with thirty elected through popular elections and thirty appointed by the Shah. Members of the Senate are also elected or appointed for four year terms. In order to vote in Iran, an individual must be twenty years of age or older in the elections for deputies to the Majlis and twenty-five years of age or older in those for the Senate. Executive authority is vested in a Cabinet which is composed of a prime minister, the heads of the various ministries and some ministers without portfolio. The ministers are responsible to the legislature and must receive its vote of confidence.

Governmental plans and actions: socio-economic improvements. One of the factors which determines the progress made by any nation is the government's recognition of the nation's socio-economic needs and the actions taken to meet these needs. A brief review of the efforts taken by the government of Iran since 1949 furnishes a background for some of the accomplishments that have been made to meet socio-economic needs and for the assumption that the government is particularly interested at the present time in efforts to improve educational opportunities throughout the country.

"In . . . 1949, the parliament passed a Plan Organization Act Establishing the Plan Organization for the task of implementing the First Seven-Year Plan."[3] This plan called for financial aid to agriculture, transportation development, industry and mines, oil industries, communication, and social projects. Twenty-one billion Rials[4] (nearly 656 million dollars) were proposed for the plan which was to extend to 1955. However, only four billion Rials were eventually made available during the period and consequently many of the proposed projects were not started or were unfinished by 1955. While this plan failed to meet the anticipated results, a second plan for the period 1955-62 was undertaken. This plan included completion of the unfinished projects started previously together with the starting of new projects. "The total appropriation for the second plan was 84 billion Rials (about 1,120 million dollars) which was soon increased to 87 billion Rials."[5] Positive accomplishments during the period were: construction of some highways, expanded facilities at major airports and railways, construction of three dams and studies for other dams, erection of some sugar, textile, and cement factories, and attention to controlling such diseases as malaria, small pox, diphtheria, and tetanus.

Since 1962 the government has implemented three sequential Five Year Plans called the Third Five Year Plan, the Fourth Five Year Plan, and the Fifth Five Year Plan. The Third Five Year Plan

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[3]Jahangir Amuzegar and M. Ali Fekrat, Iran-Economic Development under Dualistic Conditions (Chicago: The University of Chicago Press, 1971), p. 40.

[4]Ibid., p. 39.

[5]Shahpour Rassekh, "Planning for Social Change," in Iran Faces the Seventies, ed: Ehsan Yar-Shater (New York: Praeger Publishers, 1971), p. 144.

(1962-68) authorized 230 billion Rials,[6] the Fourth Five Year Plan (1968-73) 480 billion Rials, and the Fifth Five Year Plan (1973-1978) 4,698.8 billion Rials. While some minimunal expenditures had been made during the first two previous plans, the 1962-68 plan was the first to contain a line item for education. The approved budget for this plan included 17.3 billion Rials for education. This money was spent mainly for the improvement of facilities for primary education. It is to be noted that it was during this period that the Literacy Corps was organized as one means for improving educational opportunities in the country and that the Ministry of Education initiated the reorganization of elementary and secondary education.

The 1968-73 plan called for an expenditure of 480 billion Rials and Rassekh reports that ". . . 71.5 billion Rials, or approximately 15 percent of the total budget has been allocated to traditional social programs relating to education, arts and culture, health, medical services and sanitation and development projects in urban and rural areas . . . ."[7] The main efforts to this plan were to be directed toward industralization, scientific water preservation, rapid expansion of power supplies, rural rehabilitation and urban development and modernization of production particularly in agriculture. Efforts were also made to implement the plan for the reorganization of the schools which had been initiated in 1966 by the Ministry of Education.

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[6] Amuzegar and Fekrat, op. cit., p. 45.

[7] Rassekh, op. cit., p. 145.

At the present time, the government is implementing the Fifth Five Year Plan. One of the major objectives of the plan, in addition to stressing agricultural development, was ". . . to raise levels of knowledge, culture, health and social welfare, to the greatest extent possible."[8] Of the 4,698.8 billion Rials allocated for this period, 131.57 billion Rials were designated for educational purposes. One of the educational goals which was envisioned was that ". . . all urban children and 80 percent of rural children will be attending school by the end of the Fifth Plan Period."[9] It is anticipated that other very significant educational accomplishments will have been made by 1978, such as increased school buildings and the fulfillment of the reorganization plan of 1966. A still pressing educational problem is that of improving the quality of education and it was to this problem that the present study is most relevant.

Early education in Iran. Religious beliefs and practices have been significant factors in Iranian educational history. As early as 1000 B. C. Zoroaster, a Persian religious prophet, laid the foundations for religious beliefs and instruction which dominated education in Iran for many years. Even after the successful conquest of Iran by the Arabs, certain Zoroasterian traditions have continued to exist. The main object of education in Ancient

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[8]The Imperial Government of Iran, Plan and Budget Organization, Summary of the Fifth National Development Plan 1973-78 (Tehran, June, 1973), p. 1

[9]Ibid., pp. 122-123.

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Iran was to develop good character traits in children, such as obedience, conformity, and the practicing of religious rites. Xenphon (430-352 B. C.), writing about ancient Persian education said "For education of children, they (Persian) choose among the old men who can improve the moral of children."[10] While specific data are not available as to the extent of educational opportunities in ancient Iran, the areas which appear to have been emphasized were religious instruction, physical education, and reading, writing, and calculation for special class of people.[11] While religious conformity was maintained in the general population by family and community practices, it was only the children of those in positions of influence or power who received instruction beyond the normal skills necessary for survival.

With the conversion of Iran to Islam, new beliefs and practices were instigated. One change occurred in instructional practice. While previously formal teaching was under the influence of Zoroasterian rites, it was now done mainly by those associated with the Mohammedan clergy. Another change was that special schools were formed for the education of selected individuals and for those who desired to learn to read and write. One such school was called the Maktab. The school was usually conducted in one of the rooms of the mosque, in shops, or in the house of

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[10] Hassan Pirnia, The History of Ancient Iran, First Vol., Tehran, 1932, p. 246. "In Persian."

[11] Issa Sadiq, A Short History of Education in Iran (Tehran, 1973), p. 18. "In Persian."

the teacher. The primary purpose of these schools was to give preparatory training to boys who were destined to become religious leaders and who might eventually enter a higher school called the Madreseh. Boys entered the Maktab at an early age and received instruction in reading, calligraphy, and Islamic teachings. Upon successful completion of the offerings of the Maktab, individuals might continue their formal education in the Madreseh. The curriculum in the Madreseh included such areas of study as Arabic, theology, mathematics, astronomy, philosophy, and logic.

Educational changes: nineteenth and twentieth centuries. The nineteenth century was a period in which some changes in school organization, curriculum, teaching methods, and educational opportunities occurred. A number of these changes were due to educational ideas introduced from the western world. Some of the changes are evidenced by the description given by Professor Edward G. Brown of Darul-Funun College which the government had established in 1851. In describing some features of the college, Brown wrote

> Here English, French, Russian, Medicine (both ancient and modern), Mathematics and other useful accomplishments are taught on European methods. The students vary in age from mere boys to youths of eighteen or nineteen, and are distinguished by a military-looking uniforms. They not only receive their education free, but are allowed one meal a day and two suits of clothes a year at the public expense, besides being rewarded in case of satisfactory progress and good conduct, by a very liberal distribution of prizes at the end of the session.[12]

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[12] E. G. Brown, A Year Amongst the Persians (Cambridge: Cambridge University Press, 1927), pp. 103-104.

The nineteenth century saw the beginning of movements which eventually lead to Iran's present day educational system. While according to Wilber,[13] the first Ministry of Education was founded in 1855, the essential form of the present educational system dates from the organization of a society in 1897. This society became afterward known as Anjuman-i-Maaruf or Educational Council and one of its important decisions was to use the French system of education as a model for Iran. It was through the efforts of this council that a number of new elementary and high schools were established. The nineteenth century was also the period in which the government began its practice of sending individuals to Europe for educational and professional training.

While educational opportunities at the beginning of the twentieth century were still very limited, significant increases in the number of schools and in enrollment of students occurred during the reign of Reza-Shah, King of Iran from 1925 to 1941. Arfa reports that

> In 1921 there was only one teachers' college in Iran, and it was very rudimentary. In 1941 there were 36 elementary teachers' colleges and one secondary training college, providing the schools with qualified teachers. The number of primary schools rose from 440 with 44,025 pupils in 1922-23 to 2,424 with 253,837 in 1941, and that of secondary schools from 47 with 9,399 pupils . . . to 301 with 24,112 . . . .[14]

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[13]Donald N. Wilber, Iran: Past and Present (Princeton, New Jersey: University Press, 1955), p. 189.

[14]General Hassan Arfa, Under Five Shahs (Printed in Great Britain by R. and R. Clark Ltd., Edinburgh, 1964), p. 291.

Sadiq says that "In 1925 through the country 109 thousand students with 6,000 teachers existed while in 1941 Iran had 536 thousand students and 14 thousand teachers."[15] The emphasis in education started under the reign of Reza-Shah has continued to the present time. A report by the Ministry of Education[16] shows a steady increase in the number of students enrolled in the various levels of educational institutions. The report indicates that in the scholastic year 1943-44 there were 1,572 individuals enrolled in a teacher's training program and that in 1971-72 this enrollment had increased to 20,676. The individuals in technical and vocational schools increased from 1,572 in 1943-44 to 47,451 in 1971-72. Enrollment in the regular high schools had increased from 23,110 in 1943-44 to 1,140,995 in 1971-72. Elementary enrollments in regular schools increased from 237,508 pupils in 1943-44 to 2,803,641 in 1971-72. In the scholastic year 1972-73 there were 3,445,528 pupils enrolled in the regular elementary schools and in the Literacy Corps schools.

Education in Iran today: Ministries. The control of elementary and secondary education is under the Ministry of Education which is located in Tehran. The Minister is assisted in certain of his policy determinations by the High Council of Education which was established by an act of parliament in 1922. The Minister of

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[15] Sadiq, op. cit., p. 192.

[16] Ministry of Education, A Summary of Statistics of Education in Iran, Number of Students in Different Educational Programs from Scholastic Year 1943-44 through 1971-72 (Tehran, 1973, Table 2), p. 2. "In Persian."

Education is the chairman of the council which is composed of ten other individuals. The members of the council consists of the Minister of Education, the President of the University of Tehran, a Moslem Doctor of Divinity, a teacher or principal of a secondary school, a teacher or principal of an elementary school, and six other persons. All of the members, other than the Minister of Education, are either appointed by the Minister or recommended by the Minister for approval by the Council of Ministers. The major functions of the High Council of Education are: ratification of curricula and of the general regulations pertaining to instructional procedures and examinations; comparison of textbooks with official curricula; evaluation of elementary and secondary degrees obtained in foreign countries; approval of scientific decorations; and establishment of regulations for membership, responsibilities and authorities of provincial councils of education. The Ministry through its actions determines the budget, employs teachers, develops the curriculum, and prepares books for the nation's schools.

For administrative functions, Iran is divided into a number of provinces (Ostans). Each province is sub-divided into smaller administrative segments called Shahrestans. Each Shahrestan is further divided into districts and each district into groups of villages which are grouped together for administrative purposes into a single village. Central control of education in these divisions and sub-divisions has been maintained through the establishment of some offices, departments, and agencies in these

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administrative units. While this organizational plan has provided a means for maintaining control of educational materials and procedures in the Ministry, there has been in recent years, a trend to encourage more local control over educational problems.

The Ministry of Education, as previously cited, initiated in 1966 the plan for the reorganization of the schools. Prior to 1966 the organizational pattern for elementary and secondary education was six years of elementary school and six years of secondary school. In 1966, the pattern was changed by the Ministry to five years of elementary instruction followed by a three year guidance stage and four years of secondary schooling. The pattern for the present organizational design and the status of kindergarten instruction are to be discussed later in this chapter.

In addition to the Ministry of Education, two new ministries were created in 1967. These were the Ministry of Science and Higher Education and the Ministry of Culture and Fine Arts. The Ministry of Science and Higher Education is responsible for the formulation of the objectives and the guidelines that relate to scientific studies and research training in the institutes of higher learning. The principle functions of the Ministry of Culture and Fine Arts are: to protect historical buildings and artistic works; to establish and develop public libraries and museums; to facilitate the training of artists and art experts; and to lend support and encouragement to artists and to others interested in the various areas of the fine arts.

Elementary education: Kindergarten. Most of the Kindergartens in Iran are privately operated schools. They are located mainly in the larger cities and, since fees are charged, only the children of rich families attend these private schools. Children enter at age four and may remain until they are ready for the public elementary school. In 1972-73, 21,773 children were enrolled in kindergartens.[17] It is of interest to note that the government, in its 5th National Development Plan for 1973-78, had as one aim the establishment of public kindergartens. These schools are to be located mostly in small towns and villages. The plan projected an increase of children to some 580 thousand pupils in such schools.[18]

Elementary education: first cycle of general education. The present organizational plan for general education in Iran is designed to consist of two stages or cycles. The first stage or cycle is a five year primary elementary period and the second is a three year guidance stage. At the present time the primary cycle (Grades 1-5) is free and compulsory in both rural and urban areas. The second cycle is also free and it is to be declared compulsory in the future when all the primary school-age children

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[17] Ministry of Education, A Summary of Statistics of Education in Iran in Scholastic Year 1972-73, Bureau of Coordination of Plans, Statistics Department, 1973, p. 1. "In Persian."

[18] The Imperial Government of Iran, Plan and Budget Organization, Summary of the Fifth National Development Plan, Revised, 1973-78 (Tehran: July, 1974), p. 232. "In Persian."

are enrolled in the schools and there is enough money and facilities to provide for their education.

The subjects taught in the primary (elementary) schools and the number of hours per week assigned to the study of each subject are shown in Table 1. Inspection of Table 1 shows that Language and Persian Literature constitute the area of greatest emphasis followed by Art and Handicrafts and Arithmetic and Geometry in that order. According to the Ministry of Education "The objective of this stage of studies which is compulsory, free and the same for all of the children both in urban and rural areas, is to teach literacy; namely teaching reading, writing, calculation and making ready the children for adaptation with the simple conditions of living."[19]

For the first four years of the first cycle, children are evaluated by the teachers three times during each scholastic year and if satisfactory achievement has been made are promoted to the next year's period of instruction. At the end of the five year peiod, the office of education at the center of the Shahrestan gives an examination to the pupils. Children who pass this examination may register for the guidance period. Due to lack of teachers and also classrooms, the guidance stage, at the present time, is not compulsory for all the children.

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[19]Ministry of Education, New Scheme of Education of the Country, Preliminary Scheme of Educational Reform of the Country, The Department of Planning and Research, No. 1, 1965 (Shahrivar, 1344), p. 10. "In Persian."

One of the critical problems in implementing the first cycle of the general education program has been the shortage of teachers. The building or securing of adequate school facilities has also been a critical problem. However, with the efforts that are being made to accomplish the goals set forth in the 1973-78 plan, it is anticipated that ". . . all urban children and 80 percent of rural children will be attending school by the end of the Fifth Plan Period."[20]

Literacy Corps. In addition to the regular schools for elementary pupils another unit under the Ministry of Education which has been concerned with improving the education of children has been the Literacy Corps. Even under the old plan of elementary education, the lack of teachers had been a serious drawback in the staffing of schools and in efforts to reduce illiteracy in the country. This lack of teachers was particularly acute in the rural areas. In view of this shortage and as a means for providing more individuals who could be engaged in educational and community services, a Literacy Corps was created in 1963 from men of military age who had received a high school diploma. Normally men of military age are required to have 24 months of compulsory military service. With the initiation of the Literacy Corps in 1963, the men who are selected for this corps spend six months in basic military and educational training and the other eighteen months working in the villages and in educating illiterate

[20] The Imperial Government of Iran, Plan and Budget Organization, op. cit.

villagers. A Literacy Corps for women was established in 1968 and both corps are now working in the rural areas.

The individuals in these organizations not only provide formal instruction for children in the rural areas, but also for adults and assist the villagers in various local projects, such as building and repairing schools, mosques, roads and bridges, and the problems of securing adequate and unpolluted drinking water. A report released by the Ministry of Education in 1973 indicates that in the scholastic year 1972-73 the total number of boys and girls who received instruction from the rural literacy corps schools was 482,932.[21] This number did not include children who may have been in the regular schools in the villages.

Guidance stage or second cycle of general education. The guidance stage, as proposed by the Ministry of Education, became partially operative in the scholastic year 1971-72. This is a three year cycle. According to the Ministry of Education

> The objectives of the three year guidance stage are to increase the general knowledge of students for better living in society, to foster moral and intellectual virtues, and especially to discover talents and potentialities of students in theoretical, technical, and vocational branches of the secondary schools, and finally with consideration to their talents and needs of the country to guide the students to pursue their studies in the different branches of secondary school.[22]

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[21] Ministry of Education, A Summary of Statistics of Education in Iran in Scholastic Year 1972-73, op. cit., p. 7.

[22] Ministry of Education, No. 1, 1965, op. cit., p. 11.

TABLE 1.--Number of Hours per Week Spent in the Study of Each Subject in the Iranian Primary Schools* (First Cycle of General Education).

Subject Matter	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Religion and Ethics	2	2	3	3	3
Language and Persian Literature	12	12	9	9	8
Arithmetic and Geometry	3	3	4	4	5
Experimental Sciences and Hygiene	2	2	3	3	3
Social Studies	2	2	3	3	3
Art and Handicrafts	5	5	4	4	4
Physical Education	2	2	2	2	2

*Ministry of Education, New Scheme of Education of the Country, Detailed Program of Five Year Elementary Period (First Cycle of General Education), The Department of Planning and Research, No. 2, June, 1966 (Khordad, 1345), p. 5. "In Persian."

The curriculum and the number of hours to be devoted to each subject area are shown in Table 2. While the subject areas appear to be somewhat similar to those in the primary schools, this second cycle of general education has as its most important concept the providing of experiences which will show the talents and abilities of students and which will assist them in choosing future jobs and/or subsequent studies. Evaluation of students is to be similar to the evaluation procedures held for children in the primary schools. The only difference is that at the end of the three year period the office of education located at the center of a province administers an examination for the pupils. The successful students may then register for either vocational schools or for the four year academic secondary education.

TABLE 2.--The Subjects Taught in the Guidance Stage and the Number of Hours per Week Assigned to the Study of Each Subject* (Second Cycle of General Education).

Subject Matter	First Year	Second Year	Third Year
Koran-Religion and ethics	3	3	3
Language and Persian Literature	6	5	5
Experimental Sciences: physics, chemistry, natural science, biology hygiene	5	5	5
Introduction to crafts and techniques	4	4	4
Mathematics	5	5	5
Arabic		1	1
History, Geography and Social Studies	3	3	3
Foreign Language	4	4	4
Physical education and Safety	2	2	2
Arts (drawing, calligraphy, sculpturing, music)	2	2	2

*Ministry of Education, New Scheme of Education of the Country, Detailed Program of Three Year Guidance Stage (Second Cycle of General Education), The Department of Planning and Research, No. 3, July, 1967 (Tir, 1346), p. 5. "In Persian."

Secondary education: general description. A treatment of secondary education is given in order to provide the interested reader with an overall picture of Iran's total educational programs. Prior to the new plan of educations the secondary program consisted of two cycles, each of three years in length. Students who had completed the six year elementary program were admitted to the first cycle. Upon completion of this cycle, a student could follow either an academic curriculum or one designed for vocational and technical training. The academic track included mathematics, natural science, literature, and home economics for girls. The vocational and technical program provided training in agricultural practices, technical skills, and secretarial techniques. Normally such training was for three years, however, some students in the second cycle could enter an elementary teacher training center where they studied for two years. After completion of this training in the teacher's college, these individuals were allowed to teach in the elementary schools.

The new plan of secondary education, as proposed by the Ministry of Education in 1966, consists of three main tracks: theoretical education, comprehensive education, and technical-vocational education. The program for each tract covers a period of four years and the students selecting a given track attend a school which is organized to provide the facilities for that particular track. Table 3 gives the subjects and number of hours per week to be devoted to each subject in the three main tracks in the proposed secondary program for the first two years. The program for the first two years for each track consists of three curriculum subdivisions: general courses, nongeneral courses, and required courses. For the first two years, the general courses and the number of hours per week for each course are the same for all the students regardless of the track followed. Thus, all the students receive instruction in religious and moral training, Persian and Arabic languages and literature, foreign language, and physical education.

The subject matter areas available in the nongeneral division are the same for all three tracks. However, the time devoted to the various subjects varies with the track being followed and there is some selectiveness with respect to the major that a student may be taking. The theoretical track gives more time to the nongeneral courses. No time is allocated in the theoretical track to the technical and vocational courses. The technical and vocational track devotes more time to required courses which are designed to stress the knowledge and skills needed for various types of manual work. Students in this track are given practical experiences through work in the fields and workshops.

The comprehensive track encompasses some of the aspects of both the theoretical and the technical-vocational tracks. Students in this track also follow a major and take courses that apply to the specific major during both the first and second two year programs. Students who successfully complete certain majors in this track and also in the other two tracks may continue into the field of higher education.

The technical-vocational track is designed to emphasize the knowledge and skills that will enable individuals to secure productive jobs in the various branches of industry or in agriculture

TABLE 3.--Number of Hours per Week Spent in the Study of Each Course in First and Second Years in Iranian Secondary Schools.*

	Theoretical Track		Comprehensive Track		Technical Vocational Track	
	First	Second	First	Second	First	Second
General Courses:						
Religious and Moral training	2	2	2	2	2	2
Persian and Arabic language and literature	6	6	6	6	6	6
Foreign language	4	4	4	4	4	4
Physical education	3	3	3	3	3	3
Nongeneral Courses						
History, Georgraphy, and Social Studies	5	4	4	4	3	3
Art and Practical Skills	4	5	2	2	2	2
Mathematical sciences	6	6	4	4	3	2
Experimental sciences	6	6	5	5	3	2
Required Courses						
Required courses in Technical and Vocational Branches			6	6	10	12
Practical training in required courses	—	—	6	6	12	12
Total Weekly Hours	36	36	42	42	48	48

*Ministry of Education, New Scheme of Educational (No. 4), The System of Secondary Education, The Department of Planning and Research, March, 1972 (Esfand, 1350), p. 42. "In Persian."

or in rural improvements and/or social services. Approximately 50 percent of school time in the first two years is devoted to studies or work experiences in technical-vocational areas with about 80 percent of the time devoted to these areas during the last two years.

Higher Education. In order to complete the picture of the educational opportunities in Iran, the following treatment of the institutions for higher education is presented. In general, three types of institutions of higher education are to be observed today in Iran. They are the universities and autonomous public institutions, private institutions, and institutions under the ministries and government organizations.[23] The universities and autonomous public institutions of higher education have complete administrative and financial independence. They have a board of trustees which determines policies. The institutions of higher education which are affiliated with the ministries and public organizations are both dependent upon their respective ministries and organizations for educational and administrative decisions. The private institutions have to observe all due regulations laid down by the Ministry of Science and Higher Education. The responsibility for policy decisions in the field of higher education is under the administration of the Ministry of Science and Higher Education. The number of students in the institutes of Higher Education in

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[23]Bulletin of the UNESCO Regional Office for Education in Asia, Vol. VII, Number 1, September, 1972, p. 6.

scholastic year 1971-72 was 97,338.[24] Table 4 shows the distribution of students in Universities and Higher Education in scholastic years 1971-72.

TABLE 4.--Distribution of Students in Universities and Higher Education Institutions According to Their Field of Studies--1971-72.*

Total	97,338
Social sciences	21,921
Humanities	20,979
Engineering	17,451
Medical	9,893
Natural and Mathematical Sciences	15,280
Agriculture	4,154
Fine Arts	3,159
Training sciences	2,522
Law	1,979

*Plan Organization, Iran Statistics Centre, Statistical Yearbook of 1971 of the Country, Consecutive Number 326 (Tehran, 1973), p. 143. "In Persian."

Although there has been an expansion in the facilities for higher education, the present institutions can care for a fraction of the individuals that will be graduating from the secondary schools. Some 20,000 Iranian students are now attending institutions of higher learning abroad.

[24]Plan Organization, Iran Statistics Centre, Statistical Yearbook of 1971 of the Country, Consecutive Number 326 (Tehran, 1973), p. 143. "In Persian."

Historically Darul-Funun was the first college for higher education to be established. However, it operated only for a number of years and the first university to be established was the University of Tehran in 1934. This is the largest and oldest institution of higher education in Iran.

Adult Education. It is worth noting that, in addition to the plans and actions taken to improve educational opportunities for individuals from the kindergarten through the institutions of higher learning, various efforts have been underway to reduce adult illiteracy. Three major organizations are involved in reducing illiteracy in the adult population. These organizations are the National Committee for the Compaign against Illiteracy, The Literacy Corps, and a Work Orientated Adult Literacy Pilot Project.

The National Committee for the Campaign against Illiteracy was founded in 1965. Since that time this organization in Tehran and its branches in the provinces has organized literacy classes in urban and rural areas. The classes are run on a performance contract whereby teachers are paid on the basis of the number of adults that they instruct in reading and writing. The Literacy Corps, as mentioned earlier in this chapter, has been involved in teaching adults in the rural areas. The Literacy Corps started its work in 1963 and up to January, 1972, 554,781 adults had been served through the work of the Literacy Corps.[25] The Work Oriented Adult Literacy Pilot Project is a part of UNESCO's experimental

[25]Iran Almanac and Book of Facts 1972 (Tehran: Echo Institute, 1972), p. 519.

world literacy program. The program was designed to explore the possibilities of improving adult education with an emphasis on economic and social development through a functional approach. This project presently covers two distinct zones in Iran. One is Desfool, an agricultural area, and the other is Esfahan, an industrial area, including all of the cities and districts located in the province of Esfahan.

Summary. Iran is an ancient country with a history which dates as far back as 4,000 B.C. It is a relatively large country comprising over 600,000 square miles. Much of the country is a high plateau bordered by high and rugged mountains. Extreme climatic conditions occur in various parts of the country and rainfall in most of the country is about 10 inches per year. The population, on the basis of the 1966 census, is well over 25,000,000 and over half of the population are village dwellers and nomads. There are some 3,000,000 nomadic and seminomadic peoples. Ninety-eight percent of the population are Moslems.

Since 1906, the government of Iran has been a constitutional hereditary monarchy. Socio-economic planning has been underway since 1949 to develop natural resources, increase agriculture production, modernize industries, improve transportation and communication facilities, and improve the health and general living conditions of the people. Beginning with the five year plan of 1962-68, there has been specific allocations of monies for educational programs. The five year plan for 1973-78 designated 131.57 billion Rial for educational purposes.

Zoroasterian religious beliefs and practices dominated education in Iran for many years. Under Islamic influence there developed the schools known as the Maktab and the Madreseh. Although individuals who desired to learn to read and write attended the Maktab, the primary purpose of this school was to give training to boys who were destined to become religious leaders. The Madreseh was a school for those who had completed successfully the offerings in the Maktab and here Arabic, theology, mathematics, astronomy, philosophy, and logic were studied.

The nineteenth century saw the introduction of educational practices from the western world. The first Ministry of Education was established in 1855. The period from 1925-1941 was one of significant increases in the number of schools and in enrollments.

The Ministry of Education has control of elementary and secondary education. The Ministry is located in Tehran and it determines all educational policies and practices for elementary and secondary schools throughout the country. Prior to 1966 the organizational pattern for the educational program was six years of elementary schooling and six years of secondary schooling. In 1966, a reorganization of the schools occurred. This plan consisted of a pattern of five years for elementary education followed by a three year guidance period and a four year secondary stage. At the present time, the primary cycle (grades 1-5) is free and compulsory. The second cycle is also free and will be compulsory in the future when all the primary school-age children are enrolled in the primary cycle. The shortage of teachers, school buildings, and facilities are still problems in need of solution before full implementation of the first and second cycles of the plan can be accomplished.

In addition to the schools which have been established to improve educational opportunities, the government in 1963 established a man's Literacy Corps and in 1968 a Literacy Corps for women was created. The individuals in these organizations provide formal instruction in reading and writing for children and illiterate adults in rural areas and assist in local projects.

There is a Ministry of Science and Higher Education which is responsible for scientific studies and research in the institutes of higher education (universities) and for policy decisions related to higher education. There is also a Ministry of Culture and Fine Arts which is concerned with the preservation of historical sites, artistic works, and the development of facilities and programs for the various areas of the fine arts.

CHAPTER III

LITERATURE REVIEW

One of the purposes to be served by a review of literature relevant to curriculum development in science is to acquire information which could be useful in formulating a new model or which could serve as a source of ideas for individuals concerned with initiating a new science curriculum. In order to collect such information, the author has included, in addition to a review of science curriculum developments at the elementary level, a limited review of some curriculum studies or reports of science at the secondary level.

This chapter includes a review of science teaching and science curriculum developments in the United States of America, of selected elementary curriculum programs, and of the efforts to improve the implementation of science education in the United States. A limited review was also made of science curriculum developments and science teaching in other countries.

Science education in the United States of America prior to 1960. The significance that a review of the developments in science education in the United States has to the present study is the attention that has been given to the objectives of science instruction and to the development of curriculum materials to meet the objectives. The acquisition of scientific knowledge was the primary objective for many years although process skills, such as observing and experimentation were also considered desirable goals. Object Teaching, the dominant method of science in the elementary schools from about 1850-1890, had as a main purpose the training of children to make accurate observations and to develop their powers of concentration. Object Teaching, in the elementary schools, was followed by the Nature Study movement, 1890-1920, and although the main purpose here was to educate children in terms of the environment in order that their lives would be fuller and richer, such process skills as observing, inducing, and concluding were emphasized. The period between 1925-1960 was one in which the elementary science offerings were mostly subject-matter orientated, but also one in which science educators were stressing the significance of science and the skills and attitudes inherent in problem solving, scientific methods, and other procedures which were considered characteristic of scientific endeavors.

The Thirty-first yearbook of the National Society for the Study of Education[1] was a very significant publication which influenced both curricular offerings and teaching procedures. This yearbook held that the purpose of science teaching was the development of functional understandings of major generalizations of science and associated attitudes. These generalizations became the

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[1]National Society for the Study of Education, "A Program for Teaching Science," Thirty-first Yearbook, Part I (Bloomington: Public School Publishing Company, 1932).

main content materials used by textbook and curriculum writers. The resutling curriculum, according to Kuslan and Stone, ". . . consisted of the relevant readings, experiments, demonstrations, and other activities that jointly created 'functional' understanding."[2] The yearbook also dealt with teaching techniques and strongly recommended the acquisition of the generalizations by problem solving procedures. The use of problem solving or the scientific method was advocated as a means for acquiring the so-called scientific attitudes, such as looking for cause and effect relationships and open-mindedness.

The Forty-sixth Yearbook of the National Society for the Study of Education[3] was another publication which had significant impact on curriculum development and teaching in the United States. This yearbook pointed to the implications that science instruction had for individual and social development. The report reads

> Scientific discoveries and developments affect not only man's material existence but also his thinking. Instructions in science must take cognizance of the social impact of developments produced by science. It is not enough that they be understood in a technical or scientific sense; it is most important that their effects on attitudes and relationships of people be studied and understood. Science instruction has not only a great potential contribution to make but also a responsibility to help develop in our youth the qualities of mind and the attitudes that will be of

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[2]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach, 2nd ed. (Belmont, California: Wadsworth Publishing Company Inc., 1972), p. 157.

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

> greatest usefulness to them in meeting the pressing social and economic problems that face the world.[4]

In regards to the organization of the elementary science program, this yearbook stressed the importance of acquainting pupils with the broader areas of the physical and biological environment by introducing such subjects as the universe, the earth, the conditions necessary for life, living things, physical and chemical phenomena, and man's attempts to control his environment.[5] This publication was one of the first to emphasize the direct teaching for the processes of science. With respect to this point, the report says that "The elements of problem-solving behavior will be attained as objectives only to the degree that they are definitely sought and taught through appropriate learning experiences."[6]

The third yearbook of the National Society for the Study of Education which was devoted to science education gave attention to such topics as the role of science in American culture and science education for changing times. The yearbook re-emphasized that two major aspects of science teaching were knowledge and enterprise. The point is made that

> The pupil needs at each grade level to acquire a background of ordered knowledge, to develop an adequate vocabulary in science for effective communication, and to learn some facts because they are important in everyday living, such as knowledge that is useful in maintaining health,

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[4]Ibid., p. 1.

[5]Ibid., pp. 75-76.

[6]Ibid., p. 145.

> promoting safety, and interpreting the immediate environment.[7]

It is also re-emphasized that

> Science is a process in which observations and their interpretations are used to develop new concepts, to extend our understanding of the world, to suggest new areas for exploration, and to provide some predictions about the future. It is focused upon inquiry and subsequent action.[8]

Prior to the late 1950's interest in science curriculum development had been evidenced mainly by science educators, a limited number of professional educational organizations, and textbook writers. With the world wide technological and political developments of the 1950's and the awareness that the previous efforts in science education had not achieved to any marked degree scientific literacy, a new interest in science education began to be evidenced by the actions of scientists, educators, professional science organizations, and the government of the United States. This was the stimulus which lead to the attention given to science curriculum development at both the elementary and secondary levels and to the training of teachers for science teaching at both levels.

<u>New science curriculum developments and implementation: general comments and review of developments at the secondary level</u>. The science curriculum movement, the efforts to implement the new curricula, and the programs for training teachers are so extensive that all that was attempted in this review was to present

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[7]National Society for the Study of Education, "Re-thinking Science Education," The Fifty-ninth Yearbook, Part I (Chicago: University of Chicago Press, 1960), p. 35.

[8]Ibid.

selected aspects of each of these undertakings. A very significant and necessary aspect of these undertakings, that should be noted, is the fact that financial assistance and/or sponsorship or co-sponsorship was furnished by private funds or foundations, the U. S. Office of Education, or the National Science Foundation. The National Science Foundation, an independent agency of the Federal Government which was founded in 1950, has been the main sponsor or co-sponsor of most of the curriculum projects and the clearning house for review, decision making, and financial assistance for practically all the programs designed to implement the various curricula and for those programs concerned with training teachers for improved science instruction or for using the new science curriculum materials.

The first efforts to improve science instruction in the United States in the late 1950's and early 1960's were directed at science at the secondary level. A new high school physics program (PSSC) was produced by the Physical Science Study Committee which was formed in 1956. Other curriculum developments at the secondary level were undertaken by biologists, chemistists, and scientists in the area of Earth Science. The Biological Science Curriculum Study produced three distinct textbook versions for the teaching of biology. Two approaches for the Teaching of chemistry resulted in the Chemical Bond Approach and the Chemical Education Materials Study program. The Earth Science Curriculum project also developed an Earth Science program. These programs, in general, were developed by teams of scientists who were recognized scholars in their respective fields.

Concurrently with the development of the new secondary science curricula was the attention given by the National Science Foundation to the improvement of science instruction at the secondary level through summer institutes and/or conferences for scientists, science educators, and classroom teachers. One of the first efforts was to bring scientists and science educators together as a means for examining and improving the science programs in existing colleges and universities and for initiating and implementing programs designed to improve the teaching of individuals who were already teaching science in the secondary schools. Carter reports that

> Over the entire fifteen year period of operation, estimates indicate that about four thousand summer institutes provided subject matter training for nearly 200,000 participating teachers of science and mathematics from elementary, secondary, and college levels.[9]

It is to be noted that new curriculum developments were occurring in Mathematics at the same time that developments in science were taking place. The most extensive program for improving the quality of preparation of teachers already teaching science or mathematics in the secondary schools was the Academic Year Institute which began in 1956. Each institute was co-sponsored by the National Science Foundation and a college or university.

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[9]Karl Chmelowitz Carter, "A Historical Study of the Evolution of the Objectives of the National Science Foundation Teacher Training Programs, as Exemplified Specially by the Academic Year Institute Programs in Science" (Ph.D. dissertation, Michigan State Univesity, 1970), p. 53.

Participants were selected in those institutes designed for science training, mainly on the basis of their need for more academic training in the sciences and spent one year at the co-sponsoring institution. The curriculum of these programs emphasized academic science and/or mathematics courses with some training in methods of teaching. Each participant received a stipend sufficient to cover normal living expenses. The program at each institute was usually designed so that a participant could earn a Master of Arts Degree in Teaching or General Science during the one year of study. Many of the institutes had as many as fifty participants per year. It has been reported

> . . . that from 1956 through 1968-69 the National Science Foundation co-sponsored 620 Adacemic Year Institutes in which 19,376 individuals were participants at a cost of $118,060,324.[10]

While some follow-up studies pointed to the value of the institute training to the individuals and to their accomplishments in the schools in which they were teaching, the program was discontinued around 1970 due to a number of factors including the costs involved in such programs.

Another program that was instigated for the improvement of science at the secondary level was the Traveling Science Demonstration Lecture Program which was first co-sponsored by Atomic Energy Commission and the National Science Foundation. This program was initiated at the Oak Ridge Institute of Nuclear Studies. Selected individuals were given a period of training after which they

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[10]Ibid., p. 112.

visited schools and through demonstrations, lectures, and conferences attempted to assist the local teacher or teachers in ways to improve and to update their science instruction. This program was also co-sponsored by the National Science Foundation and three universities in the United States.

Through the efforts of such actions as discussed above and of the innumerable actions by professional associations, industries, and private or governmental agencies, one can infer that these actions have undoubtedly improved both curriculum offerings and instructional procedures at the secondary level. It appears that teachers are better trained, the subject matter materials have been revised and updated, and learning experiences designed to give students training in the methods used by scientists.

New science curriculum developments and implementation: elementary level. While the first concerted efforts to improve science instruction occurred at the secondary level, attention was soon given to science at the elementary level. The renewed efforts in curriculum development at the elementary level got underway at the beginning of the 1960's and since that time some twenty published programs for elementary science have been produced. The National Science Foundation, as in the field of secondary education, has sponsored or co-sponsored many of the projects which developed new elementary science programs. While none of these programs have exactly the same goals, curricular content, or evaluative procedures, almost all of the projects followed similar strategies in developing and evaluating their programs. Kuslan and Stone say that the similar strategies were:

1. A team of well-known scientists, together with elementary school teachers and educational specialists, usually under the leadership of one of the scientists, meets jointly to prepare objectives and a curriculum rationale. This meeting is followed by workshop sessions to write texts and teachers' guides, devise laboratory and other firsthand experiences, and prepare audiovisual aids and evaluative materials.

2. "Experimental" teachers are specially indoctrinated in the program during a summer or an inservice institute.

3. The "experimental" teachers test the preliminary curriculum materials and innovative methods at various grade levels in as many different schools and regions as can be secured for this trial.

4. Consultants sent out from the program headquarters visit the teachers regularly. The consultants seek to learn from the teachers and children what difficulties teachers and children are encountering. They attempt to work out ways to overcome the problems.

5. Teachers send regular reports to program headquarters about their successes and failures.

6. The field testing often takes three or more years and involves many dozens of teachers and thousands of children. Following the testing the "final" edition, which incorporates the many revisions, is published. It is accompanied by a detailed teacher's guide, kits of equipment, audiovisual aids, and other supplementary materials. These published materials then become available to any school system that wants to adopt that program.

7. Additional revisions are made as feedback from the teachers and children in the adopting systems is received, and new editions are published.[11]

The factors which appeared to be common in all the available programs, according to Rowe are:

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[11]Kuslan and Stone, op. cit., pp. 215-216.

1. What scientists do--namely, the processes in which they engage.

2. The knowledge that scientists generate and the way in which they organize and use it, i.e., the organized content and applications of science.

3. The mental and emotional development of the children, which limits what it is appropriate to do at different stages.[12]

All of the new science curriculum programs tend to stress the processes of science by having the children engage in first hand, concrete experiences. Many were designed basically to be implemented in the classroom in ways similar to the methods used by scientists in their search for valid conclusions. Accurate observation, classifying, making predictions and inferences, formulating and testing hypotheses, and drawing conclusions on the basis of reproducible evidence are some of the processes stressed to a more or less degree in most of the programs. The programs vary in content materials and some were guided in their development by different philosophical and psychological concepts.

Three of the programs which are representative of the curricular movement and which have had some national and international acceptance are Science--A Process Approach (SAPA), the Science Curriculum Improvement Study (SCIS), and the Elementary Science Study (ESS). The Science--A Process Appraoch had its beginnings in 1962 under the Commission of Science Education of the American Association for the Advancement of Science. The Science Curriculum

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[12]Mary Budd Rowe, Teaching Science As Continuous Inquiry (New York: McGraw-Hill Book Company, 1973), p. 6.

Improvement Study originated at the University of California at Berkely in 1962 and the Elementary Science Study, beginning in 1960, was developed by the Education Development Center, Newton, Massachusetts. While there are many other programs that are worthy of detailed treatment in a review of the new elementary science programs, a treatment of the three programs cited above were deemed sufficient for the main purposes of this study.

The Elementary Science Study (ESS). The elementary science study program consists of some fifty discrete units covering a wide range of subject matter in the biological and physical sciences and with some units devoted to mathematics, geography, or logic. Some examples of the titles of the units are: Growing Seeds, Gases and Airs, Behavior of Mealworms, Pendulums, Mirror Cards, Color and Form, and Batteries, Bulbs, and Other Things. Teacher's guides, film loops, and pupil kits are supportative teaching aids for some of the units. The units are not sequential and the planners did not specify the grade levels at which the units were to be used. The time needed to complete a given unit varies with the maturity and experience of the children and the time alloted to science each week. Some units may be completed, according to the authors, in three weeks while others may require twelve weeks or more.

The units were designed to give children experiences with concrete objects or situations and placed heavy emphasis upon children's natural curiosity. The desired learning situation should be one in which the children would "mess around," doing what they want to do rather than following specific teacher direction. According to the planners

> Children use materials themselves, individually or in small groups, often raising the questions themselves, answering them in their own way, using the materials in ways the teacher had not anticipated, and coming to their own conclusions.[13]

It appears that effective implementation of this program necessitates non-traditional techniques of teaching as the teacher should act as a guide rather than a dispenser of knowledge. From a review of the literature, it also appears that with this program, as with other new science curriculum programs, teachers working with ESS units need pre-service or inservice training with the subject matter contents of the program and the desired techniques for teaching the materials.

Since the objectives of the program stress the development of the spirit of inquiry and since the processes and attitudes inherent in such a spirit are difficult to determine objectively, the planners say that they did not attempt to build an evaluation program. Thus, evaluation in this program depends largely on teacher observation of such behavioral actions or attitudes as interest, involvement, curiosity, types of questions and answers, and interactions with teacher and classmates. The acquisition of cognitive knowledge is not the main criterion for achievement in this program.

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[13]R. E. Rogers and A. M. Voelker, "Programs for Improving Science Instruction in the Elementary School, Part I, ESS," Science and Children 7:38 (January-February 1970).

Kuslan and Stone report that some studies indicate that

> . . . Children in ESS classes participate more actively in science activities, produce more high-level contributions such as inferences, judgments, and opinions, give more voluntary responses, and work harder and with more purpose than do children in conventional science classes. Teachers also ask more questions, rely far less on recitation and dictation, and call on children by name much less often for answers than do teachers in regular science classes.[14]

<u>The Science Curriculum Improvement Study (SCIS)</u>. This program states as its main purpose the development of scientific literacy, which is

> . . . a sufficient knowledge and understanding of the fundamental concepts of both the biological and physical sciences for effective participation in twentieth century life.[15]

The program is both process and content oriented. The program has six units in the biological sciences and six units in the physical sciences. Teacher's guides are available for each unit. Pupil activity sheets, supplementary films, and commercially prepared equipment are likewise available for purchase.

> SCIS uses a materials-centered approach in which the elementary classroom actually becomes a laboratory. The children become acquainted with specific examples of objects and organisms, examine natural phenomena, and develop skills in manipulating and recording data. Selected materials are brought into the classroom. The children are allowed to manipulate or observe the material, sometimes freely in any way they wish and sometimes under the guidance of the teacher. As a result of these preliminary explorations, the children have a new experience--a direct physical and mental contact with the natural world.

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[14] Kuslan and Stone, op. cit., p. 227.

[15] Report of the International Clearinghouse on Science and Mathematics Curricular Developments, 1967, Edited under the direction of J. David Lockard (College Park, Maryland: International Clearing House, 1967), p. 339.

> As the next step, the teacher introduces the scientific concept that describes or explains what the children have observed. This is called the "invention" lesson. Following the invention lesson, other experiences are provided that present further examples of the concept. These are called "discovery" lessons.[16]

Thomson and Voelker report that each unit is planned to accomplish the following:

1. Make available a widely diversified program which relies to a great extent on concrete experience.
2. Relate these concrete experiences in such a way that a conceptual framework emerges with teacher guidance.
3. This framework will be more valuable to (children) than any generalizations they would make for themselves without guidance.[17]

This program, as with the ESS program, has no special evaluation instruments. Evaluation by teachers depends on their assessment of written work in manuals and worksheets and observational judgments, such as the pupil's ability to respond to questions, to make generalizations, to apply concepts to new situations, and to plan experiments.

The results of comparative studies, as well as descriptive ones, indicate that the SCIS program has been successful in developing in pupils understanding of the concepts studied and behavior patterns indicative of the processes and attitudes inherent in inquiry learning. Experiences have shown that the effective implementation of this program rests on a teacher's knowledge of the purposes and of the techniques needed to direct the learning of the

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[16] Ibid.

[17] B. S. Thomson and A. M. Voelker, "Programs for Improving Science Instruction in the Elementary School, Part II, SCIS," Science and Children 7:30 (May 1970).

pupils in accordance with the exploratory, invention, and discovery aspects of each unit. One of the significant movements in providing such training has been summer institutes and inservice workshops. Several trial centers were established for trying out the SCIS materials and summer sessions devoted to the use of the materials are still being held at various universities under the co-sponsorship of the National Science Foundation.

Science--A Process Approach (SAPA). This program is a highly structured program which was based to a large extent on the theoretical concepts of Gagné. The program was initiated under the direction of the Commission on Science Education of the American Association for the Advancement of Science and was financially assisted by the National Science Foundation. The program is a K-6 curriculum and was developed by teams of scientists, science educators, psychologists, and elementary classroom teachers. The initial work was begun in 1962. In developing the materials over a period of years, a central staff was continuously at work and several writing sessions, which were composed of invited personnel and the central staff, were held. The materials produced at these sessions were edited, printed, and tried out in classroom situations in cooperating schools. Feedback of the try-outs was secured through an extensive evaluation program. This plan of development was followed until the materials became commercially available in the late nineteen sixties.

Science--A Process Approach was designed to stress processes over content. The processes stressed include observing, communicating, classifying, using numbers, inferring, predicting, hypothesizing, manipulating variables, and interpreting data. Gagné said that

> The most striking characteristic of these materials is that they are intended to teach children the processes of science rather than what may be called science content. The goal of this approach is not an accumulation of knowledge about any particular domain. However, a variety of content is used to support the learning of the process skills.[18]

The published materials are separate self-contained teacher booklets for grades K-6 which are assembled in separate grade level packages labeled A through G. Each booklet cites the desired behavioral objectives, the rationale for the lesson and some background material, the vocabulary to be developed, the materials needed, an introductory exercise, activities which are to be done by the pupils, and appraisal and competency techniques. Theoretically the materials were designed to follow a hierarchy chart which indicates the sequence of the experiences which should be followed. Gagné contends that content and its order are the two most important factors in learning, and both must be appropriate for learning.[19]

In the studies done in schools that served as trial centers for the materials and in some other instances, the results, with

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[18]R. M. Gagné, "Elementary Science: A New Scheme of Instruction," American Association for the Advancement of Science: Miscellaneous Publications (Washington, D. C., 1965), p. 1.

[19]R. M. Gagné, "A Psychologist's Councel on Curriculum Design," Journal of Research in Science Teaching 1 (1): 27 (1963).

respect to the achievement of process goals, indicate that pupils were able to attain a high percentage of the process skills. This is another program where it is highly recommended that there be pre-and/or inservice training of teachers for those who intend to use the program.

Need for teacher preparation and efforts to provide such preparation. The need for improving the science preparation of elementary teachers has long been recognized by American educators. Studies have shown that few elementary teachers have had science majors and that many teachers avoided teaching science because of their lack of confidence in this area. From various reports, it appears that few of the teachers understand problem solving techniques for teaching and that their ability to handle demonstration and experimental situations is very poor. In recognition of these weaknesses, there has been initiated a number of kinds of undertakings to improve the science preparation of teachers, their knowledge of one or more of the new curriculum programs, and their methods of instruction in accordance with inquiry procedures.

These undertakings included summer institutes, workshops, inservice training sessions, conferences, and special assistance programs to schools serving as trial centers or to schools adopting one of the new programs. Programs were initiated whereby colleges or universities served as the centers for program implementation in schools participating in specially funded projects. It is to be noted that these undertakings, as were those made to improve teaching at the secondary level were financed largely by private funds, the U. S. Office of Education, or the National Science Foundation.

The National Science Foundation initiated a program to retrain elementary teachers which was modeled after the Academic Year Institute Program. The program was known as the Experienced Teacher Fellowship Program. The program provided training in science and mathematics for experienced elementary teachers who intended to remain in teaching. Participants spent one year on the campus of the co-sponsoring institution. They were given a stipend which was considered adequate for normal living and academic requirements. The number of participants in a given program varied with some programs supporting fifty participants. This program, while considered worthwhile, was discontinued after a few years as the costs were great and it became evident that the task of improving the preparation of the large numbers of teachers in the field in this manner was not economically feasible.

Many science and/or science education departments in colleges and universities have made revisions in their respective course offerings or created new courses in efforts to improve the preparation of elementary teachers for teaching science. Some have co-sponsored various types of innovative approaches for improving the science preparation of teachers. One such program was conducted at Michigan State University[20] where selected secondary science teachers received intensive training during a four week summer session in preparation for conducting inservice programs in cooperating Michigan Schools. These secondary teachers spent the following academic year in conducting inservice sessions in the cooperating schools. Evaluative measures used in the study supported the conclusion that secondary science teachers could make significant contributions to the science knowledge of inservice elementary teachers.

Efforts to update and improve the preparation of teachers are still being made in the United States. Various program have been approved by the National Science Foundation for teachers, science supervisor, and others associated with science teaching for the summer of 1975. Likewise, a number of separate projects have been approved throughout the country for the academic year 1975-76. A conclusion that may be drawn from the review of the literature, which should be of interest to curriculum planners in countries contemplating changes in their science programs, is that teacher training needs to be an integral part of curriculum development in order to have the curriculum implemented effectively.

Summary of trends in science education in the elementary schools. In addition to the movement to develop new science materials as exemplified by the previously discussed programs,

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[20]Julian Robert Brandou, "A Study of an Experimental Program for the In-service Science Education of Elementary School Teachers," (Ph.D. dissertation, Michigan State University, 1963).

independent authors have continued to revise or produce new science textbooks and/or teaching materials for the elementary schools. While there certainly has been a trend for commercial publishers and schools to adopt or to modify one or more of the new science programs, textbooks are still used in many elementary schools.

Some of the trends, which seem to the author to be of significance for individuals concerned with curriculum development in other countries are:

1. Scientists, psychologists, curriculum specialists, science educators, and classroom teachers are experimenting, preparing materials, testing their hypotheses, and evaluating, to improve classroom science teaching.

2. More emphasis is being placed on the use of firsthand experiences whenever possible to make the learning in science more meaningful. There is more doing with definite purpose on the part of children.

3. A discovery approach is being emphasized in which children are confronted with selected phenomena and situations and in which they suggest the problems to be solved and propose methods of solution.

4. Increasing stress is being placed on the methods of science; children are coming to understand these methods by involvement in situations which demand their use rather than by being told about "the scientific method."

5. Persistent efforts are being made to fit the science offerings and the learning methods to the needs, interests, and abilities of the learners.

6. Science in the best elementary school systems is now being thought of as a part of kindergarten through twelfth grade (and in some instances kindergarten through college) program of continuous development.

7. Supervisors, administrators, teachers, and pupils are working together to an increasing extent to plan and carry out effective programs of science study. These

efforts have resulted in much local in-service activity designed to meet the specific needs of teachers and others.

8. Considerable stress is laid on using community resources to bring science to life.

9. More scientific apparatus and equipment is being made available for use in elementary schools. In many cases this has resulted in providing material for each child's use.

10. The use of television as a teaching aid is increasing both in amount and effectiveness as teachers learn to use it when it serves sound educational purposes, in the same way that they use audiovisual aids, texts, and other learning aids.

11. Special science teachers, science supervisors, team-teaching arrangements, and teacher-aids are being used to assist classroom teachers to improve their science teaching and relieve them of some of the responsibility.[21]

Science education developments--elementary and/or secondary in some other countries than United States of America. There has been a general interest in science education throughout the world in both developed and developing countries. In England, the Nuffield Foundation was established in 1943, and it has sponsored programs in science education which closely parallels developments in the United States of America, particularly the ESS and SCIS programs. The Nuffield 5-13 science program

> . . . is open-ended and allows for the greatest amount of exploration and discovery by the pupil and the teacher. As the content is considered secondary to the process, students in these programs are free to move through a great number of experiences. They are encouraged to invent and test their own experiment, read, discuss, collect, classify, question,

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[21] Glenn O. Blough and Julius Schwartz, Elementary School Sciences and How To Teach It (New York: Holt, Rinehart, and Winston, Inc., 1969), adapted from pages 7-9 (Numbering changed and deletions not shown).

> and form conclusion based on their own experiments. Data keeping is an integral part of the work of Nuffield science and mathematics is an important tool of discovery.[22]

The Nuffield program stresses laboratory activities as the basis for instructional procedures. The fundamental approach is to

> . . . observe, experiment, keep data, pose new questions, defend your conclusions, and thrill a new to the rediscovery of an old truth. The role of teacher and student merge and all become active participants in the process of science.[23]

Teacher manuals have been developed for the 5-13 program. These manuals comprise Units dealing with subject areas in which children are likely to conduct investigations. The manuals are not to be considered as formalized syllabi to be followed exactly, but as open-ended guidelines which will assist a teacher to make the most of the available materials, the local environment, and the interests of students.

Japan is another nation in which there has been recent change in the philosophy and aims of science teaching in the elementary schools.

> The main objective of the latest Japanese elementary science curriculum is to guide children to develop familiarity with nature, and a logical and objective grasp of natural things and phenomena, through observation and investigation to deepen the understanding of nature and, to cultivate scientific attitudes and skills.[24]

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[22]Ben Werner, Jr., "Parallel Evolution of Elementary Science Programs in Great Britain, Japan, and the United States," Science and Children (December 1972), p. 20.

[23]Ibid.

[24]Ibid., p. 21.

It appears that in the area of content "at this time, the Japanese are still concerned with a sequential grade-by-grade syllabus built around three broad themes, these are 'living things and their environments,' 'substance and energy,' and 'the earth and universe'."[25] Laboratory activities are being stressed more than formerly and attention is being given to providing experiences whereby the pupils may learn through discovery procedures.

There have been some very definite steps taken in Philippine to improve the elementary science curriculum. "In 1957, The Philippine public schools adopted a new elementary curriculum which was designed to improve the teaching and understanding of health and science."[26] This program was revised in 1970 with some changes in the time alloted for science instruction and in grade placement of the science content. In recent years, attention has been given to an integrated science program. Concepcion-Medel says that

> The major task of science teaching in developing imaginative inquiry and concepts to interpret the physical and biological world and the scientific way of reaching decisions has led curriculum developers to stress upon the concepts and methods of science. The integrated science program, for example, was introduced by the Elementary Science Department project in 1966, to study, readjust and develop curriculum guides that reflect the unification of the various science fields through the organization of the content under only three main headings: living things,

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[25]Ibid.

[26]Dionisio P. Garzon, "An Analysis of the Problems of Teaching Elementary Science in the Philippine Public Schools," The Philippine Journal of Science Teachers V (September and December 1970): 27.

> matter - energy and motion, and earth and space. The learning approach emphasized personal experience with problems, materials and phenomena.[27]

An analysis of science and science education in Nigeria was done by Okonkwo in 1969. The purposes of his study were

> . . . (1) to study the role of science and science education in Nigeria and to examine how they could contribute to the solution of the problems and needs of the people of Nigeria and (2) to make proposals for the reorganization of science curriculum in Nigerian schools at the elementary and secondary levels based upon an analysis of the problems and needs of the people and to propose a teacher training program for science teachers.[28]

In discussing science in the elementary school, he notes that hygiene and nature study has been the only science offerings in the first six or eight years of school in the country. He indicates that the main method of teaching science is lecture and that in the elementary school ". . . there is not much concern or very little occasion, if any, for student experimentation."[29] One can infer from his study that the science being offered in Nigeria was not related to the needs and everyday life of the students and that the content materials and methods of teaching and evaluation did not meet the objectives of a modern science program. Okonkwo makes the following suggestions of things that should be done with respect to elementary education.

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[27]PazConcepcion-Medel, "Model--A Conceptual Framework for Environmental Education Adapted to the Philippine Environment" (Ph.D. dissertation, Michigan State University, 1974), p. 89.

[28]Augustine Ikechukwuka Okonkwo, "Science and Science Education in Nigeria" (Ph.D. dissertation, Michigan State University, 1969), p. 2.

[29]Ibid., p. 111.

1. The objectives should be concerned with developing students' powers for observation, critical thinking, and problem solving.

2. Societal needs should serve as a criterion for the selection of content.

3. The curriculum should be flexible in order to accommodate the differences in backgrounds, interests, abilities, and the localities of the students.

4. Science courses must be planned in such a way that students would be able to understand natural phenomena in terms of cause and effect.[30]

The areas of study suggested by Okonkwo were: earth, atmosphere, time and place on the earth, the body, diseases, food and nutrition, water, air, the local and regional fauna, the local and regional flora, conservation, and electricity.

In view of recent developments, it appears that curriculum planners in Nigeria have given attention to ways to diversify the teaching materials to suit the varying needs of individuals living in different environmental areas and to the contributions which science education may make to the preparation of pupils as future citizens in a rapidly changing society. The

> . . . curriculum designers are now beginning to think through the aims and objectives of science education which can make a full contribution to national development and to draw up plans for putting this type of curriculum into operation in the schools. The design of the curriculum will involve not only the production of teaching materials on a large scale, but also a massive retraining of teachers if its implementation is to become a reality.[31]

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[30]Ibid., pp. 143-145. (Comments on suggestions not given.)

[31]Shelia Haggis, "Science Education in National Development," The Science Teacher (February 1972): 50.

The need for science in the elementary schools is particularly great in that most children do not attend secondary schools. It is of interest to note that the development of integrated science teaching is being promoted by the Science Teachers Association of Nigeria. In 1971, a workshop sponsored jointly by UNESCO and the United Nation Children's Fund was held in Nigeria.

Elashhah[32] proposed a model for the development of science curriculum in the preparatory and secondary schools of the United Arab Republic. As a basis for decision making in curriculum improvement, he examined the following three major areas: cultural and social problems; the learning processes and the learner; and the nature and structure of science. He suggested that the objectives be stated from the standpoint of students rather than the teacher and that the objectives should be specific rather than broad generalizations. He concluded that the content of the science offerings was basically subject matter orientated and that there was a lack of adequate learning experiences. He also suggested the need for consistency between objectives and the evaluation programs. He proposed that a period of three years be allowed for planning and trial implementation of the model in order to evaluate the model.

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[32]Gamal A. Elashhah, "A Model for the Development of Science Curricula in the Preparatory and Secondary Schools of the United Arab Republic" (Ph.D. dissertation, Michigan State University, 1966).

Guevara[33] investigated the evolution of the official objectives of the 1944 elementary school program in science education in Venezuela, as prepared by the Ministry of Education. He points out that "The science education projects which have been developed in the United States have been the basic foundation for the improvement of the science education program in Venezuela."[34] Science--A Process Approach has been somewhat of a model for the elementary science program planners. He notes that various universities in the United States and organizations such as UNESCO, OAS, and the agency for International Development have collaborated with the Ministry of Education in developing the new science curriculum in Venezuela. Guevara suggested a mechanism for arriving at a new set of objectives for the elementary school science program. The mechanism suggested was to create a National Science Education Commission (NSEC) which "should develop a general plan of study in which the major focal points should be curriculum construction and improvement, teacher training, philosophy of Venezuelan science education, and foreign science curriculum developments."[35] An additional feature was to create a regional science education commission which "should consist of the principal, representatives of science teachers, a representative of the Ministry of Education, and

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[33]Luis Beltran Mata Guevara, "An Analysis of Objectives of Science Education in Venezuelan Elementary Schools" (Ph.D. dissertation, Michigan State University, 1972).

[34]Ibid., p. 50.

[35]Ibid., p. 81.

representatives of the community."[36] He makes a series of recommendations with respect to actions which should be taken by the Ministry of Education, such as

> The Ministry of Education should develop a new educational law which provides for: the reorganization of the educational system, a change in programs of study to suit new national and local needs, the training of new teachers at the higher education level, and the establishment of an educational tax to increase the educational budget. The Ministry of education, . . . , should promote a series of workshops; conferences; and television, newspaper, and radio programs to motivate the population to work for the development of a better educational system . . . .[37]

Karplus,[38] in writing of his recent visit to Europe, gives some indication of the plans in other countries with respect to improving science instruction. He says that

> In Italy, Hungary, Sweden, and Denmark, there are development groups consisting of scientists, teachers, and psychologists developing elementary school curricula which make extensive use of the SCIS program.[39]

According to Karplus, the physics department of the University of Rome has undertaken an inquiry approach to the entire elementary school program. One reason for the design of the project is the feeling that ". . . the relatively short time allotted to science each week does not allow children to formulate a consistent, investigative approach if they experience traditional, authority-centered instruction in the other subjects."[40] He reports that

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[36]Ibid., p. 82.

[37]Ibid., pp. 92-93.

[38]Robert Karplus, "SCIS Safari," SCIS Newsletter No. 26 (Fall, 1974).

[39]Ibid., p. 1.

[40]Ibid.

Hungary has used the SCIS materials as the basis for improving science instruction at the elementary level. So far only the physical science materials have been used in Hungary. He notes that the SCIS physical science materials have been introduced into some elementary schools in Denmark and that at the present time attention is being given in both Hungry and Denmark to the feasibility of using the SCIS life science materials in the schools. As to additional use of the SCIS materials, he reports that in Sweden, efforts have been made to improve the elementary science program through the translation and modification of the SCIS materials. As a result of the use of these materials, Swedish scholars have developed a single, integrated sequence of units that include physical and life science activities for each year.

One of the most definitive models for curriculum development was proposed by Cohen[41] for the development of a science curriculum for Australia. In developing his model, he took the position that educational practices and innovations in the area of science education in the United States had relevance for developing a science curriculum in Australia. The model he developed and the suggested plan for its implementation were based mainly on his personal experiences in the United States and upon his review and evaluation of the reports and studies concerned with science education in America. He proposed the formation of an Australian Science

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[41] David Cohen, "The Development of an Australian Science Curriculum Model" (Ph.D. dissertation, Michigan State University, 1964).

Education Foundation which would be composed of representatives of a number of existing educators and scientific organizations. While Cohen's study was concerned mainly with curriculum development at the secondary level, his reviews of curriculum development and his recommendations should be of interest to anyone attempting to formulate a model for science instruction where there is some degree of central control. Cohen presents the criteria for the model, some seventy recommendations, ideas as to implementation of the model and methods of evaluation.

There has been very positive and extensive action taken in Australia to improve science instruction in the country. In 1966, The Science Standing Committee of the Victorian Universities and Schools Examination Board (VUSEB) and the Australian Council of Education Research (ACER) established the Junior Secondary Science Project (JSSP). This project was created to produce learning materials for the first four years of revised Victorian secondary science course. This project, in 1969, was expanded and became known as the Australian Science Education Project (ASEP). In 1970, a conference was held in Melbourne for the purpose of establishing guide lines for the project. The conference was composed of ASEP staff members, education department officials from each state, science educators from universities and teacher colleges, and classroom teachers experienced in teaching science in grades 7 through 10. The conference resulted in the development of a series of proposals as to the aims for science education, the understandings to be acquired, the psychological foundations concerning the development of materials, and the criteria for selection of materials. It was proposed that the science experiences should be aimed at developing

1. Some understanding of man, his physical and biological environment, and his inter-personal relationships.
2. Skills and attitudes important for scientific investigation.
3. Some understanding of the nature, scope and limitations of science.
4. Some understanding of, and concern for, the consequences of science and technology.[41]

The aims were based on the beliefs that the acquisition of such understandings would enable children to operate more effectively in their environment and that children interest was of prime importance in the development of understandings, skills, and attitudes. It was proposed that the materials were to be developed on Piaget's stages of intellectual development. Materials were to be developed for children at the concrete stage, at the transitional stage, and at the formal stage. A unit was to be chosen for development if it

1. is consistent with the environmental scheme.
2. will allow children to see new relationships.
3. has content meaningfully related to children's everyday experiences.
4. is of potential interest to children.
5. contains student activities contributing to the development of skills and abilities.
6. has content, skills, and activities which are judged valuable by the project staff and teachers.
7. uses simple equipment whenever possible.

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[42]A. M. Lucas, ASEP, A National Curriculum Development Project in Australia, Science Education (January-March, 1972): 446.

8. is feasbile in terms of children's characteristics, school financial limitations, school equipment, school organization, and the characteristics of the present teachers.[43]

Work was started on the development of materials and it is anticipated that commercially available units will be ready for use by 1975. It appears from a list of tentative units that the project is not producing a unified sequential course of study, but materials from which teachers may select units according to their own aims, and the aims and curricula demands of their particular school. An important characteristic of some of the planned units is that they will be "open-sided" as well as "open-ended." The director of the project says

> We believe that science provides only one way of looking at the world. That science has links with social science, art, music, and many other areas is important, and leads to exciting possibilities in schools. For example motion is not simply a scientific concept, but an artistic, musical, or poetic one, depending on your point of view. These are areas that teachers and schools can be encouraged to explore in the development of their own curricula . . . . The project believes it has a duty to attempt to develop at least some materials which bridge different areas of knowledge.[44]

It is worth noting that the ASEP emphasize the preparation of teachers for implementation of the project. The founders of this organization believe that the development of science materials cannot accure in isolation and must parallel the education of teachers to use the materials. Along with the development of materials, the project aims to develop suitable tests and other

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[43]Ibid., p. 447.

[44]Ibid.

instruments for use with the completed materials. Another aim is to construct tests that will measure the stage of cognitive development of the children. As to the work being done by this project, Professor Alfred Garrett, past president of the National Science Teachers Association, who visited the project said "I have observed some of the best preplanning for curriculum study that I have seen anywhere."[45]

While the author did not attempt to review in detail international education, mention should be made of the efforts of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). This organization has been engaged in various educational endeavors for a number of years. One of the activities has been concerned with making available to developing countries literature related to the basic sciences. This organization has published, through the years, many articles, books, guides, and other materials concerning science teaching at both the elementary and secondary levels. In two sequential publications[46] attention was given to an integrated approach for the teaching of science. The reasons for this approach as cited in Volume II are:

> 1. It has become increasingly apparent that science must be an element in the general education of all children. However, the majority of children in many parts of the world do not get beyond primary school. Clearly, science needs to be introducted as an element in primary education and such science must of necessity be of an integrated type or perhaps undifferentiated would be a better term.

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[45]A. B. Garrett, "Notes on Travels in Australia," Science Teacher (January 1971): 7.

[46]UNESCO, New Trends in Integrated Science Teaching, Vol. 1 (Paris, 1971) and Vol. II (Paris, 1973).

2. At secondary level, if science is to be an element of general education, at least in the lower cycle of secondary education, some form of integrated science teaching is likely to be more appropriate than courses in the separate disciplines of physics, chemistry and biology.
3. Integrated science teaching at primary and secondary levels provides a sound basis for continuing science education either in specialist subjects or further integrated science.[47]

The purpose of these publications was to give help to people working in science curriculum planning and design and in teacher training in developing countries. An integrated science approach is discussed in both volumes and in the appendix of Volume II ninety-eight projects are cited that incorporate an integrated approach to science teaching. It is significant to note that in April, 1972, an international conference was held at the University of Maryland for the purpose of exploring ways and means to advance a unified approach to science teaching.[48] An outgrowth of this meeting was the formation of the International Council of Associations for Science Education (ICASE). One of the concerns of this association is to ". . . foster cooperative efforts to improve science education for all children and youth throughout the world."[49] The association has considered plans for the preparation of a handbook for science teaching to supplement The New UNESCO Source Book for Science Teaching.

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[47]UNESCO, New Trends in Integrated Science Teaching, Vol. II (Paris, 1973), p. 5.

[48]Mary E. Hawkins, "International Conference on the Education of Teachers for Integrated Science," Science Teacher (May 1973): 43-46.

[49]Science Education News, A.A.A.S. (September 1974): 5.

Summary. The acquisition of scientific knowledge was the main goal of science instruction in the United States for many years. However, even as early as 1850 attention was being given to the importance of the skills and processes inherent in scientific inquiry. The importance of the skills and processes of scientific methods of inquiry and of the attitudes associated with such inquiry continued to be stressed by science educators as evidenced by three Yearbooks of the National Society for the Study of Education. These publications made significant contributions to curriculum planners in regards to content areas of study and to problem solving techniques as an even more important goal than the acquisition of cognitive information.

Beginning in the late 1950's and early 1960's concerted efforts were started, mainly by scientists and/or scientific organizations, to improve science education in the United States. These efforts were directed first at improvement in secondary science offerings and resulted in new curriculum programs in physics, biological science, chemistry, and earth science. Teams of scientists were employed for the development of each of the respective programs. The programs up-dated the scientific knowledge in the respective fields, presented new learning experiences, and gave emphasis to the ways by which scientists investigate problems and arrive at valid conclusions. The financing of these programs came mainly from private funds or foundations, the

U. S. Office of Education, or the National Science Foundation. Concurrently with the development of the curriculum materials, attention was given to the dissemination of information about the programs and to the training of teachers to implement the new materials.

The efforts for improving elementary science instruction followed much the same patterns used in the secondary movement. Separate teams of scientists, science educators, pyschologists, and classroom teachers were assembled to write, revise, and produce the various new elementary curricula. Some twenty published programs are now commercially available. While the programs vary in content materials, most tend to stress the processes of science and are designed to be implemented in the classroom in ways similar to the methods used by scientists in their search for valid conclusions. The processes stressed in almost all of the programs are accurate observation, classification, hypothesis formation, testing hypotheses (experimentation), predicting, inferring, and drawing conclusions on the basis of evidence. Three of the representative programs are: Science--A Process Approach (SAPA), Science Curriculum Improvement Study (SCIS), and Elementary Science Study (ESS). The training of teachers to implement the various programs has been attempted through workshops, inservice programs, trial centers, and special programs with school systems.

The curriculum developments in other countries that were reviewed indicate that there is an awareness, on the part of scientists, science educators, professional organizations, and governmental agencies, of the need to revise or create new science programs. Some countries have made changes in their programs through modifications of the new curriculum programs developed in the United States and others have produced programs designed to meet specific conditions within a given country.

CHAPTER IV

NATURE OF SCIENCE AND SCIENTIFIC INQUIRY

A review of the literature relevant to this study indicates the importance that the curriculum programs and those associated with improving science education attach to science and to scientific inquiry or discovery learning. In order to furnish some additional background, a treatment of the nature of science and of scientific inquiry is presented in this chapter. Since there has been a trend in curriculum development in America to involve educational psychologists in the planning and writing of curriculum materials and, in the light of the attention that has recently been given to the ideas of Piaget, a treatment of some psychological concepts relevant to curriculum construction and implementation is also included in this chapter.

Nature of science. In examining man's beliefs about the nature of science, it is apparent that his concepts and the importance attached to science have differed markedly. The word itself comes from the Latin word, "scientia," which means knowledge. Historically, it is of interest to note that in ancient cultures, including the Greek's, there was no hard and fast border between philosophy and the various branches of science. A philosopher was a person who knew the knowledge of his time in philosophy, mathematics, science, and even in history and the arts. Philosophy was the all inclusive domain of knowledge and this concept was the dominant one through the dark ages and even in the area of enlightenment. Campbell says that ". . . even at the beginning of the nineteenth century, all learning was called philosophy."[1] However, there had occurred, even prior to Galileo's time (1564-1642), differences of opinion as to the ways by which knowledge was acquired and these differences, together with the nature of the things for which man was seeking knowledge and the significance attached to such knowledge, lead to the separation of the sciences from the realm of the philosopher. Science had been for many only an intellectual activity to satisfy one's curiosity as to the nature of things, both physical and biological. This aspect has remained one of man's drives. However, the applications of scientific knowledge to almost every facet of man's individual and societal life has been the most obvious result of science in the nineteenth and twentieth centuries.

There are even today differences of opinion as to the nature of science and it is difficult to construct an universally accepted definition.[2] Conant says that "The diversity stems in part from real differences in judgment as to the nature of scientific work

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[1]Norman Campbell, What is Science (New York: Dover Publication, Inc., 1952), p. 7.

[2]John M. Woodburn, "Science Defined Versus Indefinable. A Personal Attempt to Define Science," The Science Teacher 34:8 (November, 1967): 27-30.

but more often from the desire of the writer or author to emphasize one or another aspect of the development of the physical and biological sciences."[3] One definition of science which has been held by many individuals is that science is an organized body of facts *per se*. Science educators today consider this definition to describe only one aspect of science--the products of science. They do not negate this aspect. However, they look upon this aspect as a static condition and point to the interpretation that science involves particular ways by which the facts, concepts, and conceptual schemes are discovered and established as warranted conclusions. That is, science is a dynamic endeavor that leads to new facts, concepts, and conceptual schemes. This aspect of science is characterized by the processes and attitudes exhibited by scientists in their work.

While scientists and science educators may differ as to the emphasis which they put on the products and processes of science, the following quotations express the concept that science, in its modern meaning, incorporates both the products of science and the processes by which the products are secured. Science is

> . . . a cumulative and endless series of empirical observations which result in the formulation of concepts and theories, . . . with both concepts and theories being subject to modification in the light of further empirical observations. Thus science is both a body of knowledge

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[3]James B. Conant, *Science and Common Sense* (New Haven: Yale University Press, 1951), p. 24.

and a process of acquiring and refining knowledge, and one of its principle characteristics is its dynamic nature.[4]

Science is a process in which observations and their interpretations are used to develop new concepts, to extend our understanding of the world, to suggest new areas for exploration, and to provide some prediction about the future. It is focused upon inquiry and subsequent action.[5]

Science . . . is a human enterprise including the ongoing processes of seeking explanations and understandings of the natural world, and also including that which the processes produce--man's storehouse of knowledge. Science is process and product.[6]

One of the most quotated definitions of science and of its nature is that formulated by Conant. He says

. . . Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation . . . . Science is a speculative enterprise. The validity of a new idea and the significances of a new experimental finding are to be measured by the consequences--consequences in terms of other ideas and other experiments. Thus conceived, science is not a quest for certainty; it is rather a quest which is successful only to the degree that it is continuous.[7]

The educational implication that one may make from these definitions, in science curriculum planning, is that science should be presented in such ways as to stress both the products--the cumulative knowledge in specific areas of science--and the

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[4]Frederick L. Fitzpatrick, ed., Policies for Science Education, Science Manpower Project (New York: Bureau of Publications, Teachers College, Columbia University, 1960), p. IX.

[5]National Society for the Study of Education, Rethinking Science Education in The Fifty-ninth Yearbook, Part I (Chicago: The University of Chicago Press, 1960), p. 35.

[6]Robert Stallberg, ed., Planning for Excellence in High School Science (Washington, D. C.: National Science Teachers Association, 1961), p. 15.

[7]Conant, op. cit., pp. 25-26.

processes by which such knowledge was secured and by which new knowledge is likewise obtained. In the literature review, presented in Chapter III, it was apparent that, at the elementary level, there was no general agreement as to what subject matter (product) should constitute the science curriculum. This problem of subject matter selection, as far as this study is concerned, is given attention in the discussion of the model itself. The review also indicated that the main theme in most of the new elementary and secondary science curricula was the emphasis on the processes of science which characterize scientific endeavor. A discussion of some of the main features of these processes should be of interest and use to curriculum planners who are considering incorporating such processes into a science curriculum.

Processes of science. The literature reveals, as mentioned in Chapter III, that science educators in America have been advocating for a period of more than forty years that the acquisition of the skills and attitudes inherent in the scientific method or problem solving be one of the main objectives of science education. These skills were thought of as the ability to identify and state a problem, to collect relevant data concerning the problem, to formulate a hypothesis that would explain the problem, to test the hypothesis, and on the basis of the evidence collected in testing the hypothesis to either refute or confirm the hypothesis; that is, the ability to draw a valid conclusion on the basis of the evidence. These steps or processes represented a logical way to arrive at a solution for a problem and since they were often the pattern to be observed in some successful scientific endeavors, they were termed the scientific method or problem solving technique. Thus the scientific method or problem solving approach became the standard procedure for teaching science for a number of years. In time it became recognized that this step-by-step procedure was not necessarily characteristic of scientific endeavor. Stollberg points out that

> Problem-solving is not a series of fixed steps described in science texts from three or up to ten steps in number . . . it includes an assortment, not a pattern of skills, attitudes, and habits.[8]

While the literature abounds in such phrases as "the scientific method," "problem solving," "critical thinking," "inquiry learning," and "discovery learning," it is generally accepted among most science educators that these designations indicate, in general, some common processes and, while minor differences exist, the designations mean much the same. Therefore curriculum planners should not be too concerned as to what descriptive phrase is used, such as inquiry or discovery, but rather to the processes and attitudes used in attempting to secure knowledge, whether that knowledge be old or new. The point that should be emphasized is that there is no one scientific method, no one means for inquiry or discovery, or any other rigid combinations of actions which one can say are necessarily the processes and attitudes which when used will lead to the solution of every problem.

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[8]Robert J. Stollberg, "Problem Solving. The Precious Gem in Science Teaching," <u>The Science Teacher</u> 23 (1956): 227-228.

The basic process of scientific endeavor, by whatever term one may wish to use, is accurate observation. In science, observation, at least in the beginning of one's search for knowledge, is the basis for all scientific interpretations and understandings of the physical and biological worlds. Thus, it is most significant in science curriculum construction that the content and learning experiences are such that children will receive training in making accurate observations. The children should have experiences by which they learn that observations may be made by use of the senses of sight, smell, taste, touch, and hearing. They should also learn that differences in the sensitivity of these organs in different individuals may cause differences of opinions relative to observations of the same object or situation.

A science curriculum should be so developed that the learner will have direct contact, whenever possible, with the actual object, situation, or event which is to be studied. This provides for training in observation whereby the learner acquires perceptions through first hand experiences rather than relying on indirect sources of information. A desirable concept associated with first hand experience is that children may learn that others may also observe the same object or event and that it is by the verifying of observations that facts are established in scientific work.

Another process of science which is stressed today in science education is that of classification. Observations, in and of themselves, can be limited to descriptive features and there may be no obvious relationships between isolated observations. However, when one looks for the similarities and differences in their observations they may discover patterns of grouping which gives order or new meaning to their observations. Classification is a most important process in the scientist's attempt to make order out of seemingly disorder. It is one of the processes stressed in the new science curriculum programs in the United States and feedback reports indicate that children are successful in acquiring this skill.

In addition to observing and classifying which are processes which have universal application, the employment of experimentation, whenever feasible, is an essential feature for testing hypotheses in science. While elementary school children may not be ready for involved experiments, there are innumerable situations suitable for elementary pupils, such as the factors necessary for the germination of seeds or the kind of soil in which plants grow best which can provide pupils with the control and experimental conditions that characterize experiments.

Curriculum planners in America have given a great deal of attention to incorporating the processes of science in the programs. Science--A Process Approach (SAPA), as mentioned in Chapter III, was designed basically to implement the processes. This program at early elementary instruction stresses: recognizing and using space/time relations; recognizing and using numbers and number relations; observing; classifying; measuring; communicating; inferring; and predicting. At the intermediate grades, the integrated scientific processes stressed are: formulating hypotheses; making operational definitions; controlling and manipulating variables; experimenting; formulating models; and interpreting data.[9]

A strong case may be made for stressing any of the above processes. For example, quantification or exact measurement is essential for many kinds of scientific work. Thus, children at an early age need to have experiences in measuring and its importance in many daily experiences. Likewise children need to know the conditions which allows for plausible predictions and the ability to distinguish between fact and inference.

Science educators since the early 1930's have advocated the desirability of pupils acquiring such attitudes as intellectual honesty, curiosity, accuracy, open-mindedness, freedom from bias, looking for cause-and-effect relationships, and suspended judgment. The new science curriculum programs are not designed to teach directly for the acquisition of these attitudes although one may assume that the planners considered them to be concomitant outcomes of good science instruction. Many science educators believe that learning situations for the direct teaching of these attitudes should be designed. This is a problem that curriculum planners could give some additional attention in their efforts to develop new programs.

In summary, the significant inference to be made from the above treatment of the nature of science and the processes which

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[9]American Association for the Advancement of Science, Science--A Process Approach. Commentary for Teachers, 2nd experimental ed. (Washington, D. C., 1964), p. 18.

characterize scientific endeavor is that curriculum planners in science should determine on the basis of defined criteria the products that children would most likely need to know and select or develop learning experiences by which children will acquire the ability to use the processes of science. The main overall general objectives for science instruction are, therefore, the acquisition of useful and meaningful knowledge-products and processes that influence man's thinking and thereby his beliefs and actions.

Objectives for science instruction in American elementary schools. The general objectives encompass both the products and processes of science. In the publication New Developments in Elementary School Science, the following quotation reads:

> For the elementary school, as well as for all other levels of education, the objectives of science instruction center around growth in understanding of science concepts and in ability to participate in the process of scientific inquiry . . . . Particular kinds of learning activities must be provided; namely, Experimentation to discover meaning, Investigation of problems, Evaluation of hypotheses, Exploration to find out the nature of things, Manipulation of equipment and materials that afford perceptual experiences, Tests of conclusions, Application of knowledge and skills to explain and interpret events observed in the environment.[10]

The main objective cited for the Science Curriculum Improvement Study (SCIS) is the development of scientific literacy which implies the acquisition of knowledge and effective participation in modern society. According to the producers of Science--A Process Approach (SAPA),

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[10]National Science Teachers Association, New Developments in Elementary School Science (Washington, D. C.: National Science Teachers Association, 1963), p. 33.

> The first task and central purpose of science education is to awaken in the child, whether or not he will become a professional scientist, a sense of the joy, the excitment, and the intellectual power of science. Education in science, like education in letters and arts, will enlarge the child's appreciation of his world; it will also lead him to a better understanding of the range and limits of man's control over nature.[11]

Jacobsen says that the goals of science instruction to be achieved from a study of science in the elementary school are:

> (a) the building of a world view that is in conformance with the view of our world and our universe now being developed in the sciences.
> (b) the fostering of an understanding of the conceptual structure of science.
> (c) the development of skill in using some of the key processes of science.
> (d) the encouragement of an informed appreciation of man, and of how science affects modern man and his society.[12]

He also says that science instruction should be directed in such ways as to prepare children for effective citizenship and to gain an understanding of the human body and how to care for it.[13]

The objectives cited above are illustrative of the kinds of general statements that are to be found in articles, textbook series, yearbooks, and curriculum programs which are concerned with science at the elementary school. In the main, these general objectives are stated in very broad concepts of achievement, such as understanding the major generalizations of science or the development of the skills in problem solving. While there is

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[11]American Association for the Advancement of Science, Ibid., p. 6.

[12]Willard J. Jacobson, The New Elementary School Science (New York: Van Nostrand Reinhold Company, 1970), p. vii.

[13]Ibid., p. 17.

apparently a place for these kinds of objectives, educators have been stressing the desirability of developing more specific operational goals which will indicate the actual behaviors of pupils with respect to the learning situations. Science--A Process Approach (SAPA) has developed such goals for all of its materials. Behavioral objectives are characterized by the use of such action words as identify, name, order, describe, distinguish, demonstrate, classify, and state a rule. For example a child could be shown a series of pictures of birds and to the question "Which is a picture of a Sparrow?" the child would identify the picture of the sparrow by pointing to the correct picture or he might be asked to name the bird shown in a given picture. Under headings which could be considered major goals of science instruction, Carin and Sund cite the following behavioral objects which they indicate that a pupil after having a science course should be able to achieve.

(1) <u>Knowledge</u>
Read and state the meaning of certain scientific facts and concepts. Show that he can apply scientific principles. When a problem situation is stated requiring the application of some scientific principle, a child has learned that he should be able to apply the principle.

(2) <u>Instrumental Skills</u>
Manipulate basic science equipment, interpret and prepare maps, graphs, charts, and tables appropriate to problems.

(3) <u>Problem-Solving Skills</u>
Demonstrate problem-solving skills such as: Observing, inferring, sensing and defining problems, making hypotheses, outlining scientific procedures to test hypotheses, carrying out an investigation, controlling and manipulating variables, formulating models, making valid conclusions, recognizing and using space and time relations, recognizing and using number and number relations, classifying, measuring, communicating, and making operational definitions.

(4) Scientific Attitudes
Demonstrate such scientific attitudes as open-mindedness by being willing to consider new facts in making judgments withholding conclusions until all available facts are in, using controls, generalizing with sufficient evidence.

(5) Appreciations
Describe the uses, benefits, and limitations of science to society.

(6) Interests
Indicate interest by reading, collecting, studying, or becoming involved in some scientific activity as a leisure time pursuit.[14]

An examination of the goals of elementary science instruction in America leads one to conclude that science educators hold that, while the acquisition of subject matter is an important goal, the goal that is even more important is the development of the processes and attitudes of science. Most of the new curriculum programs were developed on this belief. Thus, this is one concept that curriculum planners may want to consider in the development of new programs in science at the elementary level.

Some psychological concepts relevant for curriculum development. Learning is the ultimate goal of all educational experiences. The term learning has many interpretations, as Taba indicates in the following statement.

> Learning is complex and there are many different kinds: mastering motor skills, memorizing information, learning feelings, concepts and intellectual skills, such as generalizing, scientific inquiry and problem solving.[15]

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[14]Arthur A. Carin and Robert B. Sund, Teaching Science Through Discovery, 2nd ed. (Columbus, Ohio: Charles E. Merrill Publishing Co., 1970), p. 25.

[15]Hilda Taba, Curriculum Development-Theory and Practice (New York: Harcourt, Brace and World, Inc., 1962), p. 78.

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One thing that was noticeable in the make-up of the elementary science curriculum planners for many of the projects in the United States was the inclusion of psychologists and classroom teachers. To the author, this appears to be a very desirable thing, as there are many theories of learning and the resources of knowledgeable individuals should certainly enhance the development of a well designed curriculum.

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things that characterize the learning in each category. These categories are: stimulus-response, discriminations, motor chains, verbal chains, concepts, principles, and strategies. Gagné contends that content and its order are necessary for learning and an application of this contention is evidenced in the structural learning hierarchies which characterize the Science--A Process Approach (SAPA). He also contends that prior learning should be one of the guides in setting learning situations. Briefly stated, Gagné's model is a cumulative learning model in which such processes as observing, classifying, predicting, and inferring are stressed as means for developing in children patterns of behavior which will better enable them to acquire new concepts and principles and to develop strategies for various kinds of actions.

Besides such things as mental development and the order and sequence of learning experiences, learning theories, as a rule, include treatments of such psychological factors as motivation and principles of learning. These aspects of learning, when incorporated in curriculum development, can establish the guide lines for classroom procedures and are significant not only as facilitators for learning, but also are important in the development of a child's attitudes and interests and his desires for achievement. The building of a curriculum model that stresses extrinsic motivation differs widely from one that is designed basically for intrinsic motivation and curriculum planners need to be cognizant of this aspect of learning. The effects of reward and punishment are likewise important psychological concepts related to motivational factors that affect behavior. Skinner's reinforcement-learning theory has direct significance as to types of activities included in a curriculum and also in the ways that teachers implement the activities.

Educational psychologists and others have formulated from the results of research or on the basis of learning theories principles of learning which affect teaching methods. Adequate consideration of such principles, like previously mentioned points-of-view relative to learning, extends beyond the scope of this thesis. However, a limited listing of such principles, as given by Carin and Sund, is representative of principles of teaching and has significance to curriculum developers with respect to the objectives of a program, to the materials to be included, and to the methods employed in the organization and implementation of the program. In view of this significance a list of selected principles follows:

(a) In the learning process, active participation by the learner is preferable to passivity, such as listening to a lecture or watching a motion picture.
(b) The learning situations are dominated by purpose or goals set by the learner or accepted by him.
(c) The learning situation, to be of maximum value, must be realistic and meaningful to the learner and should take place within a rich and satisfying environment.
(d) Learning processes occur best through a wide variety of experiences and subject matter which are unified around a core of purpose.
(e) The learner will persist through difficulties to the extent that he feels the objectives are worthwhile.
(f) Learning processes proceed most effectively when the experiences, materials, and desired results are carefully adjusted to the maturity and background of the learner.

(g) Learning processes proceed most effectively under the type of instructional guidance which stimulates without dominating or coercing, which provides for successes rather than too many failures, which encourages rather than discourages.
(h) The products of the learning processes are socially useful patterns of action, values, meanings, attitudes, appreciation, abilities, and skills.
(i) Transfer to new tasks will be better if, in learning, the learner can discover relationships for himself and if he had experiences of applying the principles within a variety of tasks.
(j) The learning process and the achievement of results is materially related to individual differences among the learners.[23]

Inquiry and/or discovery learning. While the early literature relative to science teaching employed such terms as "the scientific method," "problem solving," and "methods of science" to designate the desired means for teaching science at both the elementary and secondary level, the terms most recently used are inquiry and/or discovery learning. As mentioned previously, many science educators consider the terms to be synonyms since the writers describing these respective terms indicate relative similar learning environments and stress the same basic processes which are to be employed by students in the learning situations. The terms inquiry and discovery are often equated as evidenced by Kuslan and Stone's comments regarding

> The new currents in science teaching stress the importance of deriving learning from direct experiences with scientific phenomena. This approach, modeled after the

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[23]Arthur Carin and Robert B. Sund, Teaching Science Through Discovery (Columbus, Ohio: Charles E. Merrill Books, Inc., 1964), p. 43. (List adapted by the author. Credit for the various principles cited by Carin and Sound in a footnote on page 43 of their text.)

> investigative processes of scientists, is called the inquiry or discovery approach.[24]

Sund and Trowbridge in noting the stress that has been placed on inquiry as an approach to science instruction, say that "The inquiry, or discovery, method stresses student-centered rather than teacher-centered class instruction."[25] In describing this method, they say that

> The inquiry approach does not stress the accumulation of authoritative information. It is more concerned with students discovering how scientists come to know what they know. Inquiry is defined as a search for knowledge or truth. The emphasis is on the search rather than the product.[26]

Bruner,[27] in commenting on discovery learning and the significance that is attached to this method, says that this approach includes all forms of obtaining knowledge for oneself by the use of one's own mind and that when one speaks to mathematicians or physicists or historians, one encounters repeatedly an expression of faith in the powerful effects that come from permitting the student to put things together for himself, to be his own discoverer. Bruner believes that discovery is in its essence a matter of reorganizing or transforming evidence in such a way that one is enabled

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[24]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach (Belmont, California: Wadsworth Publishing Co., Inc., 1968), p. v.

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[26]Ibid., p. 37.

[27]Jerome S. Bruner, "The Act of Discovery," Harvard Educational Review 33, 1 (Winter, 1963): 125.

to go beyond the evidence so reassembled to additional new insights. He states further that "Our aim as teachers is to give our student as firm a grasp of a subject as we can, and to make him as autonomous and self-propelled a thinker as we can--one who will go along on his own after formal schooling has ended."[28] Bruner contends discovery learning can make the following contributions.

1. It increases the intellectual potency of the learner. Children not only organize study procedures to discover relationships but also learn in ways that facilitate assimilation of data in general problem solving.

2. The learner shifts from dependence on extrinsic to intrinsic rewards. Intrinsic reward arises from confidence in one's ability to discover. It means that mastery becomes inner directed.

3. Mastery of the heuristics of discovery enhances its transfer value. "Transfer value arises from the belief that the child strengthens his capacity to pursue inquiry only by participating in inquiry."[29] Transfer in this framework is the acquisition of a mastery of an approach to solving problems.

4. Learning by discovery expedites memory processing. The inference that can be made from this statement is that "The more children are encouraged to organize their learning in

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[28]Ibid., p. 126.

[29]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach, 2nd ed. (Belmont, California: Wadsworth Publishing Co., Inc., 1972), p. 188.

conceptual structures of their own devising, the greater is the probability that they can quickly and effectively retrieve that learning."[30] Bruner says that

> . . . In general, material that is organized in terms of a person's own interests and cognitive structures is material that has the best chance of being accessible in memory. That is to say, it is more likely to be placed along routes that are connected to one's own ways of intellectual travel.
> In sum, the very attitudes and activities that characterize "figuring out" or "discovering," things for oneself also seem to have the effect of making material more readily accessible to memory.[31]

In analyzing the various things that characterize discovery or inquiry learning, the dominant characteristic is that the processes of science are emphasized over content, but not to the exclusion of content. In setting learning situations and in directing such situations discovery learning involves two features of learning. The first feature is that the approach is an inductive one. That is, one proceeds from the specific to the general. The educational implication of this feature is that students should have experiences with specific objects, situations, or events and from such experience be able to generalize their findings. For example, an individual may observe cells in every plant and animal tissue he examines. From these observations, the individual may then generalize that the tissues of all plants and animals are composed of cells. The significant point is that the learning situation should start with observations and/or activities which will

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[30]Ibid., p. 189.

[31]Bruner, op. cit., p. 135.

provide the learner with specific facts or concepts which may then be generalized to all members of the class of objects, situations, or events that are being studied or investigated.

The second feature of learning by discovery is the concept of trial and error learning. Inherent in this concept is the belief that pupils themselves should attempt to secure evidence which either supports or refutes their ideas. That is, pupils should be allowed to check their ideas. If they do not succeed in securing confirmative evidence, then they should re-examine the situation, offer new ideas, and again attempt to arrive at a warranted conclusion. The approach is to make a trial and if it fails, then one trys again, this general pattern is repeated until a satisfactory answer is obtained or until there seems to be no good reason to consider future trials.

While there are severe critics of the discovery approach to learning, Ausubel[32] being one of these, various writers cite many advantages for discovery or inquiry learning both as to desirable teaching situations and as to the acquisition of the processes of science by the children. In summary, some of the commonly cited advantages are:

1. Children and teachers habitually employ scientific processes, such as comparing,observing, estimating, measuring, classifying, and drawing conclusions. It provides an environment where children investigate problems individually or in groups.

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[32]David J. Ausubel, "Learning by Discovery: Rationale and Mystique," Bulletin of the National Association of Secondary-School Principles (December, 1961), pp. 18-58.

2. Children have experiences with a wide variety of situations and materials where suggestions may be given as to ways to secure answers, but the answers to the problems are not given. That is, the children must find the answers themselves through their own discovery procedures.

3. The learning situations provide pupils with direct, concrete experiences. That is, they engage in activities with actual objects or situations rather than being told about them.

4. Students are encouraged to seek reasons for their beliefs and conclusions. They learn to establish reason for their conclusions on the basis of evidence. They ask themselves such questions as "How do I know?" and "Am I justified in making this conclusion?"

5. Children have opportunities to take the responsibility for gathering facts, for proposing hypotheses, for testing their own hypotheses, and for summarizing data and drawing tentative conclusions. They learn that conclusions are never absolute, but may change as new information is obtained.

6. Discovery learning contributes to intellectual excitement, motivation, and pleasurable experiences. There is a shift from extrinsic to intrinsic rewards, as suggested by Bruner. It provides evidence for children that there is regularity in the universe and that phenomena are reproducible.

A quotation from Sinclair and Kamii emphasizes the nature and significance of discovery learning.

> The basic understanding is a matter of active learning, which can be facilitated by constructing situations where the children can slowly build up their strategies in their

> own way. In the children's discoveries, each new idea must integrate what went on before and the activity of discovering itself must constitute the dynamic force which leads the child on to apply his newly found knowledge to new situations.[33]

Summary. Science today is considered a human endeavor that encompasses two distinct but inseparable features. One feature is the facts, concepts, and conceptual schemes which constitute man's cumulative knowledge of the physical and biological worlds--the so-called products of science. The other feature is the dynamic nature of the scientific endeavor which is characterized by the ways by which the facts, concepts, and conceptual schemes have been obtained and by which new knowledge is acquired--the processes of science. These processes include observing, classifying, accurate measuring, formulating hypotheses, experimenting, predicting, inferring, and drawing conclusions on the basis of evidence. In light of these two inseparable concepts of science, the main objectives for science instruction are the acquisition of selected subject matter information and of behavioral patterns which will demonstrate a child's ability to use the processes and attitudes of science in their learning experiences. The emphasis placed on these two objectives varies, however, the trend is to give more emphasis in instructional situations to the process goal than to the product objective.

The materials developed in the new science curriculum projects and in the ways to implement them indicate that attention

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[33] H. Sinclair and C. Kamii, "Some Implications of Piaget's Theory for Teaching Young Children, School Review 70 (February 1970): 182.

has been given to incorporating some points-of-view relative to the ways children learn. In general, learning is conceived of as an activity or process carried on by the learner. Thus, experiences are designed for children to be doing things with actual objects or engaged in investigating concrete situations. Piaget's position that learning is a continual restructing of one's mental activities and not merely an adding on to previous knowledge together with his ideas as to the stages of mental growth have influenced the development of some of the new science curriculum programs. It appears, from the literature that attention has also been directed at setting learning situations in accordance with some generally recognized principles of learning, such as active participation by the learner is preferable to passivity and the learning situation should be meaningful to the child and should take place in a rich and satisfying environment.

The approach most commonly used to describe the implementation of elementary science in the United States is inquiry or discovery learning. This approach is characterized by having children employ the processes of science in their learning experiences, by having concrete objects or situations for pupils to observe and to investigate, by children making their own hypotheses, testing by various means including experimenting, collecting and organizing information, and drawing conclusions, and by procedures which provide for inductive thinking and trial and error learning. Among the advantages claimed by the advocates of discovery learning are:

children learn to solve problems for themselves, they learn to rely upon their own observations and to seek reasons for their conclusions, they learn the tentative nature of knowledge, and that nature is not capricious, but that there is order in the universe.

CHAPTER V

THE MODEL

The model for the development and implementation of an elementary school science curriculum for Iran was assumed to be adaptable and functional within the present administrative pattern of education in Iran. There are several valid reasons for making this assumption. The Ministry of Education has been active in attempting to improve educational opportunities for a number of years and has already within its personnel knowledgeable individuals who are concerned with efforts to improve the educational opportunities of the country. It has established a framework of divisions and sub-divisions throughout the nation that are designed to facilitate communication and the implementation of its educational programs. The Ministry of Education, as an established division of the government, determines the requests to the legislative bodies for monies to initiate and implement educational programs. The model suggested in this study would require substantial financing and the only way this could be achieved is through the requests of the Ministry of Education. In order for the development and implementation of the curriculum to become effective there must be commitment by the government and the establishment of guidelines whereby the various facets of the model will be coordinated. In view of these conditions, the present model was conceived as a means for decision making relative to further efforts within the Ministry of Education for continued improvement of the educational opportunities in Iran. The detailed discussion of the model and the recommendations pertaining to the component features of the model are presented in this chapter.

Formation of a Curriculum Development Committee. The basic unit for the model for the development and implementation of a science curriculum in the elementary schools of Iran is a curriculum development committee. This committee should be formed as an integral body under the administration of the Ministry of Education in Iran with its recommendations and actions subject to review and final decision making by the High Council of Education. It is recommended that this committee, in addition to regular ministry staff members, be composed of scientists, science educators, educational psychologists, elementary classroom teachers representative of the various geographical locations in Iran, evaluation and curriculum specialists, supervisors, and administrators. In order to have adequate representation of knowledgeable individuals on this committee, it is proposed that the committee size number between twenty-five and thirty individuals. The selection of the members to constitute the committee should reside with the Minister of Education and the Minister should designate the chairperson for the committee. In the selection of individuals for the committee, those selected should be able to commit themselves to the work schedules necessary for the various tasks and responsibilities facing the committee.

As a projected plan for committee action, it is suggested that the first official meeting of the committee be a one week conference devoted to the examination of the tasks to be undertaken and to the formulation of the procedures to be followed in the work ahead. An examination of the model presented in this study and the suggested recommendations could be used as a basis for the decisions which the committee would make at this beginning stage of its work.

The interrelated components of the model are: science curriculum-objectives and content; teaching procedures instructional materials including audiovisual aids; pupil evaluation; teacher training; and model evaluation. In order to furnish some relevant information the committee concerning each of these interrelated components, a rationale and recommendations for each feature of the model was prepared. It is to be recognized that the points-of-view expressed in the treatment of each facet of the model are based on the author's examination of the literature in the various model areas and on his interpretations and evaluation of recent science curriculum developments and means of implementation. These points-of-view are presented as a working base for decision making by the curriculum development committee or by the agency which might be assigned the tasks pertaining to a specific feature of the model.

apparently a place for these kinds of objectives, educators have been stressing the desirability of developing more specific operational goals which will indicate the actual behaviors of pupils with respect to the learning situations. Science--A Process Approach (SAPA) has developed such goals for all of its materials. Behavioral objectives are characterized by the use of such action words as identify, name, order, describe, distinguish, demonstrate, classify, and state a rule. For example a child could be shown a series of pictures of birds and to the question "Which is a picture of a Sparrow?" the child would identify the picture of the sparrow by pointing to the correct picture or he might be asked to name the bird shown in a given picture. Under headings which could be considered major goals of science instruction, Carin and Sund cite the following behavioral objects which they indicate that a pupil after having a science course should be able to achieve.

(1) Knowledge
Read and state the meaning of certain scientific facts and concepts. Show that he can apply scientific principles. When a problem situation is stated requiring the application of some scientific principle, a child has learned that he should be able to apply the principle.

(2) Instrumental Skills
Manipulate basic science equipment, interpret and prepare maps, graphs, charts, and tables appropriate to problems.

(3) Problem-Solving Skills
Demonstrate problem-solving skills such as: Observing, inferring, sensing and defining problems, making hypotheses, outlining scientific procedures to test hypotheses, carrying out an investigation, controlling and manipulating variables, formulating models, making valid conclusions, recognizing and using space and time relations, recognizing and using number and number relations, classifying, measuring, communicating, and making operational definitions.

(4) Scientific Attitudes
Demonstrate such scientific attitudes as open-mindedness by being willing to consider new facts in making judgments withholding conclusions until all available facts are in, using controls, generalizing with sufficient evidence.
(5) Appreciations
Describe the uses, benefits, and limitations of science to society.
(6) Interests
Indicate interest by reading, collecting, studying, or becoming involved in some scientific activity as a leisure time pursuit.[14]

An examination of the goals of elementary science instruction in America leads one to conclude that science educators hold that, while the acquisition of subject matter is an important goal, the goal that is even more important is the development of the processes and attitudes of science. Most of the new curriculum programs were developed on this belief. Thus, this is one concept that curriculum planners may want to consider in the development of new programs in science at the elementary level.

Some psychological concepts relevant for curriculum development. Learning is the ultimate goal of all educational experiences. The term learning has many interpretations, as Taba indicates in the following statement.

> Learning is complex and there are many different kinds: mastering motor skills, memorizing information, learning feelings, concepts and intellectual skills, such as generalizing, scientific inquiry and problem solving.[15]

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[22] Robert B. Sund and Leslie W. Trowbridge, Teaching Science by Inquiry in the Secondary Schools (Columbus, Ohio: Charles E. Merrill Publishing Co., 1973), p. 50.

things that characterize the learning in each category. These categories are: stimulus-response, discriminations, motor chains, verbal chains, concepts, principles, and strategies. Gagné contends that content and its order are necessary for learning and an application of this contention is evidenced in the structural learning hierarchies which characterize the Science--A Process Approach (SAPA). He also contends that prior learning should be one of the guides in setting learning situations. Briefly stated, Gagné's model is a cumulative learning model in which such processes as observing, classifying, predicting, and inferring are stressed as means for developing in children patterns of behavior which will better enable them to acquire new concepts and principles and to develop strategies for various kinds of actions.

Besides such things as mental development and the order and sequence of learning experiences, learning theories, as a rule, include treatments of such psychological factors as motivation and principles of learning. These aspects of learning, when incorporated in curriculum development, can establish the guide lines for classroom procedures and are significant not only as facilitators for learning, but also are important in the development of a child's attitudes and interests and his desires for achievement. The building of a curriculum model that stresses extrinsic motivation differs widely from one that is designed basically for intrinsic motivation and curriculum planners need to be cognizant of this aspect of learning. The effects of reward and punishment are likewise important psychological concepts related to motivational factors that affect behavior. Skinner's reinforcement-learning theory has direct significance as to types of activities included in a curriculum and also in the ways that teachers implement the activities.

Educational psychologists and others have formulated from the results of research or on the basis of learning theories principles of learning which affect teaching methods. Adequate consideration of such principles, like previously mentioned points-of-view relative to learning, extends beyond the scope of this thesis. However, a limited listing of such principles, as given by Carin and Sund, is representative of principles of teaching and has significance to curriculum developers with respect to the objectives of a program, to the materials to be included, and to the methods employed in the organization and implementation of the program. In view of this significance a list of selected principles follows:

(a) In the learning process, active participation by the learner is preferable to passivity, such as listening to a lecture or watching a motion picture.
(b) The learning situations are dominated by purpose or goals set by the learner or accepted by him.
(c) The learning situation, to be of maximum value, must be realistic and meaningful to the learner and should take place within a rich and satisfying environment.
(d) Learning processes occur best through a wide variety of experiences and subject matter which are unified around a core of purpose.
(e) The learner will persist through difficulties to the extent that he feels the objectives are worthwhile.
(f) Learning processes proceed most effectively when the experiences, materials, and desired results are carefully adjusted to the maturity and background of the learner.

(g) Learning processes proceed most effectively under the type of instructional guidance which stimulates without dominating or coercing, which provides for successes rather than too many failures, which encourages rather than discourages.
(h) The products of the learning processes are socially useful patterns of action, values, meanings, attitudes, appreciation, abilities, and skills.
(i) Transfer to new tasks will be better if, in learning, the learner can discover relationships for himself and if he had experiences of applying the principles within a variety of tasks.
(j) The learning process and the achievement of results is materially related to individual differences among the learners.[23]

Inquiry and/or discovery learning. While the early literature relative to science teaching employed such terms as "the scientific method," "problem solving," and "methods of science" to designate the desired means for teaching science at both the elementary and secondary level, the terms most recently used are inquiry and/or discovery learning. As mentioned previously, many science educators consider the terms to be synonyms since the writers describing these respective terms indicate relative similar learning environments and stress the same basic processes which are to be employed by students in the learning situations. The terms inquiry and discovery are often equated as evidenced by Kuslan and Stone's comments regarding

> The new currents in science teaching stress the importance of deriving learning from direct experiences with scientific phenomena. This approach, modeled after the

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[23]Arthur Carin and Robert B. Sund, Teaching Science Through Discovery (Columbus, Ohio: Charles E. Merrill Books, Inc., 1964), p. 43. (List adapted by the author. Credit for the various principles cited by Carin and Sound in a footnote on page 43 of their text.)

> investigative processes of scientists, is called the inquiry or discovery approach.[24]

Sund and Trowbridge in noting the stress that has been placed on inquiry as an approach to science instruction, say that "The inquiry, or discovery, method stresses student-centered rather than teacher-centered class instruction."[25] In describing this method, they say that

> The inquiry approach does not stress the accumulation of authoritative information. It is more concerned with students discovering how scientists come to know what they know. Inquiry is defined as a search for knowledge or truth. The emphasis is on the search rather than the product.[26]

Bruner,[27] in commenting on discovery learning and the significance that is attached to this method, says that this approach includes all forms of obtaining knowledge for oneself by the use of one's own mind and that when one speaks to mathematicians or physicists or historians, one encounters repeatedly an expression of faith in the powerful effects that come from permitting the student to put things together for himself, to be his own discoverer. Bruner believes that discovery is in its essence a matter of reorganizing or transforming evidence in such a way that one is enabled

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[24]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach (Belmont, California: Wadsworth Publishing Co., Inc., 1968), p. v.

[25]Robert B. Sund and Leslie W. Trowbridge, Teaching Science by Inquiry in the Secondary School (Columbus: Charles E. Merrill Books, Inc., 1967), p. v.

[26]Ibid., p. 37.

[27]Jerome S. Bruner, "The Act of Discovery," Harvard Educational Review 33, 1 (Winter, 1963): 125.

to go beyond the evidence so reassembled to additional new insights. He states further that "Our aim as teachers is to give our student as firm a grasp of a subject as we can, and to make him as autonomous and self-propelled a thinker as we can--one who will go along on his own after formal schooling has ended."[28] Bruner contends discovery learning can make the following contributions.

1. It increases the intellectual potency of the learner. Children not only organize study procedures to discover relationships but also learn in ways that facilitate assimilation of data in general problem solving.

2. The learner shifts from dependence on extrinsic to intrinsic rewards. Intrinsic reward arises from confidence in one's ability to discover. It means that mastery becomes inner directed.

3. Mastery of the heuristics of discovery enhances its transfer value. "Transfer value arises from the belief that the child strengthens his capacity to pursue inquiry only by participating in inquiry."[29] Transfer in this framework is the acquisition of a mastery of an approach to solving problems.

4. Learning by discovery expedites memory processing. The inference that can be made from this statement is that "The more children are encouraged to organize their learning in

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[28]Ibid., p. 126.

[29]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach, 2nd ed. (Belmont, California: Wadsworth Publishing Co., Inc., 1972), p. 188.

conceptual structures of their own devising, the greater is the probability that they can quickly and effectively retrieve that learning."[30] Bruner says that

> . . . In general, material that is organized in terms of a person's own interests and cognitive structures is material that has the best chance of being accessible in memory. That is to say, it is more likely to be placed along routes that are connected to one's own ways of intellectual travel.
>
> In sum, the very attitudes and activities that characterize "figuring out" or "discovering," things for oneself also seem to have the effect of making material more readily accessible to memory.[31]

In analyzing the various things that characterize discovery or inquiry learning, the dominant characteristic is that the processes of science are emphasized over content, but not to the exclusion of content. In setting learning situations and in directing such situations discovery learning involves two features of learning. The first feature is that the approach is an inductive one. That is, one proceeds from the specific to the general. The educational implication of this feature is that students should have experiences with specific objects, situations, or events and from such experience be able to generalize their findings. For example, an individual may observe cells in every plant and animal tissue he examines. From these observations, the individual may then generalize that the tissues of all plants and animals are composed of cells. The significant point is that the learning situation should start with observations and/or activities which will

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[30] Ibid., p. 189.

[31] Bruner, op. cit., p. 135.

provide the learner with specific facts or concepts which may then be generalized to all members of the class of objects, situations, or events that are being studied or investigated.

The second feature of learning by discovery is the concept of trial and error learning. Inherent in this concept is the belief that pupils themselves should attempt to secure evidence which either supports or refutes their ideas. That is, pupils should be allowed to check their ideas. If they do not succeed in securing confirmative evidence, then they should re-examine the situation, offer new ideas, and again attempt to arrive at a warranted conclusion. The approach is to make a trial and if it fails, then one trys again, this general pattern is repeated until a satisfactory answer is obtained or until there seems to be no good reason to consider future trials.

While there are severe critics of the discovery approach to learning, Ausubel[32] being one of these, various writers cite many advantages for discovery or inquiry learning both as to desirable teaching situations and as to the acquisition of the processes of science by the children. In summary, some of the commonly cited advantages are:

1. Children and teachers habitually employ scientific processes, such as comparing,observing, estimating, measuring, classifying, and drawing conclusions. It provides an environment where children investigate problems individually or in groups.

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[32]David J. Ausubel, "Learning by Discovery: Rationale and Mystique," Bulletin of the National Association of Secondary-School Principles (December, 1961), pp. 18-58.

2. Children have experiences with a wide variety of situations and materials where suggestions may be given as to ways to secure answers, but the answers to the problems are not given. That is, the children must find the answers themselves through their own discovery procedures.

3. The learning situations provide pupils with direct, concrete experiences. That is, they engage in activities with actual objects or situations rather than being told about them.

4. Students are encouraged to seek reasons for their beliefs and conclusions. They learn to establish reason for their conclusions on the basis of evidence. They ask themselves such questions as "How do I know?" and "Am I justified in making this conclusion?"

5. Children have opportunities to take the responsibility for gathering facts, for proposing hypotheses, for testing their own hypotheses, and for summarizing data and drawing tentative conclusions. They learn that conclusions are never absolute, but may change as new information is obtained.

6. Discovery learning contributes to intellectual excitement, motivation, and pleasurable experiences. There is a shift from extrinsic to intrinsic rewards, as suggested by Bruner. It provides evidence for children that there is regularity in the universe and that phenomena are reproducible.

A quotation from Sinclair and Kamii emphasizes the nature and significance of discovery learning.

> The basic understanding is a matter of active learning, which can be facilitated by constructing situations where the children can slowly build up their strategies in their

> own way. In the children's discoveries, each new idea must integrate what went on before and the activity of discovering itself must constitute the dynamic force which leads the child on to apply his newly found knowledge to new situations.[33]

Summary. Science today is considered a human endeavor that encompasses two distinct but inseparable features. One feature is the facts, concepts, and conceptual schemes which constitute man's cumulative knowledge of the physical and biological worlds--the so-called products of science. The other feature is the dynamic nature of the scientific endeavor which is characterized by the ways by which the facts, concepts, and conceptual schemes have been obtained and by which new knowledge is acquired--the processes of science. These processes include observing, classifying, accurate measuring, formulating hypotheses, experimenting, predicting, inferring, and drawing conclusions on the basis of evidence. In light of these two inseparable concepts of science, the main objectives for science instruction are the acquisition of selected subject matter information and of behavioral patterns which will demonstrate a child's ability to use the processes and attitudes of science in their learning experiences. The emphasis placed on these two objectives varies, however, the trend is to give more emphasis in instructional situations to the process goal than to the product objective.

The materials developed in the new science curriculum projects and in the ways to implement them indicate that attention

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[33]H. Sinclair and C. Kamii, "Some Implications of Piaget's Theory for Teaching Young Children, School Review 70 (February 1970): 182.

has been given to incorporating some points-of-view relative to the ways children learn. In general, learning is conceived of as an activity or process carried on by the learner. Thus, experiences are designed for children to be doing things with actual objects or engaged in investigating concrete situations. Piaget's position that learning is a continual restructing of one's mental activities and not merely an adding on to previous knowledge together with his ideas as to the stages of mental growth have influenced the development of some of the new science curriculum programs. It appears, from the literature that attention has also been directed at setting learning situations in accordance with some generally recognized principles of learning, such as active participation by the learner is preferable to passivity and the learning situation should be meaningful to the child and should take place in a rich and satisfying environment.

The approach most commonly used to describe the implementation of elementary science in the United States is inquiry or discovery learning. This approach is characterized by having children employ the processes of science in their learning experiences, by having concrete objects or situations for pupils to observe and to investigate, by children making their own hypotheses, testing by various means including experimenting, collecting and organizing information, and drawing conclusions, and by procedures which provide for inductive thinking and trial and error learning. Among the advantages claimed by the advocates of discovery learning are:

children learn to solve problems for themselves, they learn to rely upon their own observations and to seek reasons for their conclusions, they learn the tentative nature of knowledge, and that nature is not capricious, but that there is order in the universe.

CHAPTER V

THE MODEL

The model for the development and implementation of an elementary school science curriculum for Iran was assumed to be adaptable and functional within the present administrative pattern of education in Iran. There are several valid reasons for making this assumption. The Ministry of Education has been active in attempting to improve educational opportunities for a number of years and has already within its personnel knowledgeable individuals who are concerned with efforts to improve the educational opportunities of the country. It has established a framework of divisions and sub-divisions throughout the nation that are designed to facilitate communication and the implementation of its educational programs. The Ministry of Education, as an established division of the government, determines the requests to the legislative bodies for monies to initiate and implement educational programs. The model suggested in this study would require substantial financing and the only way this could be achieved is through the requests of the Ministry of Education. In order for the development and implementation of the curriculum to become effective there must be commitment by the government and the establishment of guidelines whereby the various facets of the model will be coordinated. In view of these conditions, the present model was conceived as a means for decision making relative to further efforts within the Ministry of Education for continued improvement of the educational opportunities in Iran. The detailed discussion of the model and the recommendations pertaining to the component features of the model are presented in this chapter.

Formation of a Curriculum Development Committee. The basic unit for the model for the development and implementation of a science curriculum in the elementary schools of Iran is a curriculum development committee. This committee should be formed as an integral body under the administration of the Ministry of Education in Iran with its recommendations and actions subject to review and final decision making by the High Council of Education. It is recommended that this committee, in addition to regular ministry staff members, be composed of scientists, science educators, educational psychologists, elementary classroom teachers representative of the various geographical locations in Iran, evaluation and curriculum specialists, supervisors, and administrators. In order to have adequate representation of knowledgeable individuals on this committee, it is proposed that the committee size number between twenty-five and thirty individuals. The selection of the members to constitute the committee should reside with the Minister of Education and the Minister should designate the chairperson for the committee. In the selection of individuals for the committee, those selected should be able to commit themselves to the work schedules necessary for the various tasks and responsibilities facing the committee.

As a projected plan for committee action, it is suggested that the first official meeting of the committee be a one week conference devoted to the examination of the tasks to be undertaken and to the formulation of the procedures to be followed in the work ahead. An examination of the model presented in this study and the suggested recommendations could be used as a basis for the decisions which the committee would make at this beginning stage of its work.

The interrelated components of the model are: science curriculum-objectives and content; teaching procedures instructional materials including audiovisual aids; pupil evaluation; teacher training; and model evaluation. In order to furnish some relevant information the committee concerning each of these interrelated components, a rationale and recommendations for each feature of the model was prepared. It is to be recognized that the points-of-view expressed in the treatment of each facet of the model are based on the author's examination of the literature in the various model areas and on his interpretations and evaluation of recent science curriculum developments and means of implementation. These points-of-view are presented as a working base for decision making by the curriculum development committee or by the agency which might be assigned the tasks pertaining to a specific feature of the model.

<u>Elementary science curriculum component: objectives of science instruction at the elementary level</u>. In considering the objectives for elementary science it is useful to examine the factors which determine to a large measure general educational goals as well as those designed for specific subject matter areas. This is advisable in order for subject matter goals to be supportative of the overall educational goals of a society. General educational objectives reflect at any one time the political, social, cultural, economic, philosophical, and moral and religious beliefs and practices or conditions of a given society. They are the basic guidelines for the establishment and the implementation of the agencies, the contents, and the instructional techniques employed for the education of the members of the society. Taba says that

> The chief function of stating aims on such general levels is to provide an orientation to the main emphasis in educational programs. Aims on this level establish what might be described as a philosophy of education and are only a step toward translating the needs and values of society and of individuals into an educational program.[1]

Since the factors which affect goals vary with the needs and values of different societies, the general or broad educational goals will vary according to the overall needs of a given nation. This concept is particularly applicable to a developing nation such as Iran.

While this study has covered in Chapters I and II some of the conditions which indicate general educational goals, such as

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[1]Hilda Taba, <u>Curriculum Development. Theory and Practice</u> (New York: Harcourt, Brace and World, Inc., 1962), p. 196.

reducing illiteracy and fatalistic beliefs, increasing effective and productive participation in community activities, training for job opportunities, increasing individual feelings of worthwhileness and self-confidence, reducing apathy, and the improvement of living conditions through increased knowledge of ways to utilize natural resources and of desirable health practices, detailed attention was directed only at the establishment of objectives of science instruction at the elementary school. These goals that pertain to a given subject area are referred to as specific goals in order to differentiate them from the general educational goals.

It was assumed in the treatment of science objectives that such objectives would contribute either directly or indirectly to the general education goals of the country. In considering goals for science at the elementary level, it should be noted that two kinds of specific objectives need to be formulated. There should be goals which are designed as desired outcomes for children having had science instruction throughout the elementary cycle and then there are goals which apply to the units or experiences in the science curriculum at each grade level. The determination of the nature of these two levels of goals is significant in the development of a new science curriculum as the objectives should be the guidelines for the selection of the subject matter content and the teaching procedures to be used, and the basis of the evaluation techniques that will be employed in assessing pupil achievement toward the attainment of the goals. It is suggested that the determination of the goals for science in the elementary school be made by the curriculum development committee as a first step in its work and that the objectives pertaining to units be left to the various sub-committees.

In establishing either general educational goals or the goals for science at the elementary level, it should be noted that objectives may be classified in various ways. Bloom and his associates have developed a taxonomy of educational objectives which comprise the following three categories: cognitive, affective, and psychomotor domains. The cognitive domain ". . . includes those objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills."[2] The affective domain ". . . includes objectives which describe changes in interest, attitudes, and values, and the development of appreciations and adequate adjustment."[3] The psychomotor domain includes physical manipulation and motor abilities. It is important for curriculum designers to be cognizant of the ways goals may be classified in order that goals will be established which will provide desired direction for the development of the teaching materials and the instructional procedures.

The problem facing curriculum designers concerned with specific objectives is to first determine the contributions that a given subject area, and in this study the area of science education, can make to bringing about behavioral changes in individuals and

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[2]Benjamin S. Bloom, ed., Taxonomy of Educational Objectives. The Classification of Educational Goals, Handbook 1, Cognitive Domain (New York: David McKay Company, Inc., 1968), p. 7.

[3]Ibid., pp. 7-8.

to the general improvement of societal living. As a background for examining this problem, the nature of science was discussed in Chapter IV. The most obvious contributions of science are the products (facts, concepts, and conceptual schemes) which have resulted in the technological developments of the twentieth century and in man's cumulative knowledge of the world in which he lives. The processes and attitudes in scientific endeavors are considered by many educators to have produced significant changes in man's thinking and that these attributes are desirable educational goals. More specifically science and/or scientific endeavor has contributed

1. to an understanding of the nature of natural phenomena. It provides one with the basic knowledge and conceptual schemes that give meaning to such things as the structure of matter, to changes in the earth's surface, to the nature of living things and the life processes, and to innumerable physical, chemical, and biological situations in daily living.

2. to the developments which have produced changes in man's living conditions. Technological achievements are evidenced in almost every facet of human living: in transportation, in communication, in modern building developments, in agricultural practices, in food production, and in manufactured products. In fact, scientific achievements have been largely responsible for the physical and societal conditions that exist in today's world.

3. to man's thinking and to his actions. The processes and attitudes inherent in scientific endeavors can contribute to

one's ability to think critically and to secure information and understandings based on observable evidence and/or testable hypotheses from which warranted conclusions may be drawn. The significance of this influence of scientific endeavor pertains to not only the thinking and acting of individuals, but also to world societal decisions that could affect life on this planet.

4. to the interest and intellectual growth of individuals. Science offers opportunities to stimulate one's curiosity and provides a basis for understanding the interrelationships that exist in nature and the affects that science has upon modern man and the world society.

With a recognition of the valid contributions which science can make, attention should be directed to the criteria to be followed in establishing the goals. The following suggestions are offered as criteria for objectives for science instruction in the elementary schools of Iran.

1. The objectives should be most worthwhile relative to the knowledge to be acquired by the pupils. That is, decisions should be made as to the need for the information. There should be valid reasons as to how such information would contribute to such things as a child's understanding of the environment, his health, his interest in things around him, and his acquisition of information which may be needed for understanding more complex facts and concepts as he progresses through the grades.

2. The objectives should be most worthwhile in terms of the processes and attitudes which contribute to the pupil's ability

to think critically, to distinguish between facts and inferences or unfounded beliefs and superstitions, to observe accurately, collect relevant information, and to draw conclusions on the basis of testable evidence, to look for cause and effect relationships, and to recognize that there is order in the universe.

3. The objectives should be realistic and attainable by the pupils. This is an important criterion as objectives are the bases for the subject content and pupil activities in curriculum development. Objectives are considered attainable when they meet the needs, interests, previous experiences, and physical and mental development of the learner. Piaget's stages of mental development offer some guidelines relative to the formulation of objectives which could be attainable by pupils at varying age levels.

4. Objectives should be stated in meaningful terms and should indicate, whenever feasible, the specific behavioral abilities which are to be expected as a result of science instruction. Tyler says that

> Education is a process of changing the behavior patterns of people. This is using behavior in the broad sense to include thinking and feeling as well as overt action. When education is viewed in this way, it is clear that educational objectives then, represent the kinds of changes in behavior that an educational institution seeks to bring about in its students.[4]

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[4]Ralph W. Tyler, Basic Principles of Curriculum and Instruction (Chicago: The University of Chicago Press, 1959), p. 4.

The significance of content to behavioral changes in relation to objectives is evidenced by Tabla's statement that

> . . . the most useful and clearest statements of objectives are those which specify both the kind of behavior reaction that is expected and the content to which it applies, such as the ability to interpret accurately data on taxation, or the ability to differentiate between facts and opinions.[5]

5. Objectives should be formulated in terms which permit valid evaluation. The point of significance relative to this criterion is that if an objective cannot be evaluated effectively there is no warranted reason for its inclusion as an objective.

6. Objectives should be definable as to those that are considered obtainable as a result of relatively immediate instruction and as to those that are acquired through various experiences over an extended period of time.

In support of the need for development of the latter objectives, Taba says

> Objectives need to be conceived in terms of a continuity of growth over a long period of time and through different contexts, each more exacting than the previous one, rather than as terminal points, confined to a subject, a grade level, or even a specific activity.[6]

In the rationale presented regarding objectives, the author recognizes that the present program in teaching experimental science in Iran contains objectives which are potentially worthwhile. An examination of the present objectives for experimental science in Iranian schools show the following objectives.

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[5]Taba, op. cit., p. 200.

[6]Ibid., p. 203.

1. Knowing the nature.
2. Recognizing the relations that exist between him and his environment.
3. Creating logical (scientific) and accurate thinking in the child in order to enable him to recognize facts from superstitions.
4. By using scientific methods (observation, experiment, study, field-trips, asking informed persons and consulting them) develop ability in solving new problems and discovery of new facts.
5. Acquiring experiences and developing skills in them and by using scientific method securing confidence and reliance in research.
6. Becoming interested and curious about his environment and understanding order in natural phenomena.
7. Understanding the advantages and disadvantages of science for human being.
8. Finding an increasing interest in science and pursuing scientific methods.
9. Fostering in him the sense of curiosity and to develop in the child the attitude of critical thinking.
10. Acquiring a knowledge of cause and effect.
11. Developing an understanding over the environment, and control of natural forces.[7]

The present rationale does not negate such objectives, but rather attempts to enlarge and to clarify the bases for objectives as a means for more definable goals which would provide the basic guidelines for curriculum development in science.

Recommendation 1. The curriculum development committee undertake as its first task the determination of the values that science instruction may have for elementary school children in Iran and upon the basis of such values formulate the objectives for science in the elementary schools in Iran.

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[7]Ministry of Education, New Scheme of Education of the Country, Detailed Program of Five Year Elementary Period--(First Cycle of General Education)--The Department of Planning and Research No. 2 (June 1966) (Khordad 1345), p. 11. "In Persian." (Literal translation.)

For the deliberations of the committee, the author offers the following examples of behavioral objectives which he considers worthwhile and attainable by children during the elementary cycle. Children should acquire the ability to

1. state or to recognize selected scientific facts and concepts from the subject matter areas of living things, the environment, health, matter and energy, and the earth.

2. offer explanations of selected natural phenomena on the basis of valid evidence.

3. name, identify, or accurately describe living or non-living things, situations, or events.

4. read science materials at the appropriate grade level.

5. demonstrate such process skills as accurate observing, measuring, classifying, inferring, predicting, interpreting data, collecting relevant data, hypothesizing, and testing hypotheses.

6. distinguish between facts and inferences or opinions or superstitions.

7. plan and to carry out procedures for attempting to solve new problems.

8. seek explanations for themselves through reading, experimenting, inquiry procedures, and consulting with knowledgeable individuals.

In addition to such behavioral objectives as cited above, children during the elementary cycle should experience growth toward the attainment of such science objectives as

1. an understanding of the interrelationships which exist in the environment and of the significance of these interrelationships in regards to life on the earth.

2. an understanding of and the actual practice of the knowledge that relates to one's health, to the improvement of the environment, and to man's efforts to improve living conditions.

3. an awareness and an understanding of the advantages of scientific endeavors for individual and societal use and development and also of the potential disadvantages and limitations.

4. the development of such attitudes as open-mindedness, suspended judgment, seeking cause-and-effect relationships, and self-reliance.

5. the development of personal interests in science and of the belief that one does have the ability to influence his own fate.

Elementary science curriculum component: subject matter content and learning experiences. Curriculum should be considered more than a "course of study." The position taken in this study is that the science curriculum for the elementary school encompasses the total experiences of the children in this area of study and, in addition, their experiences in the total school environment. While it is necessary as an operational procedure to limit the building of a science curriculum to the subject matter of science, it should be recognized that the science curriculum is not an end in itself. A child's learning goes on both in the classroom and also outside the classroom. Therefore, efforts should be made in a specific curriculum project to provide content and experiences that not only contribute to the attainment of specific objectives but which also have significance and application in other courses and life experiences and thereby contribute to a child's development with respect to general educational goals.

Four interrelated tasks confront curriculum developers. These are: determination of the values inherent in a given discipline and the formulation of the objectives; the selection of the subject matter content and the learning experiences considered necessary to the attainment of the objectives; the organization of the content and experiences in accordance with the methods which are to be employed in teaching; and the provisions for evaluation of pupil progress toward the achievement of the established goals. The preceding section covered points-of-view relative to considerations with respect to the formulation of objectives. The next logical step in the tasks to be faced by the proposed curriculum development committee would be the selection of the science subject matter content and the learning experiences. While content and learning experiences may be considered by some individuals to convey the same meaning, Taba contends that the objectives to be achieved through content are different from those established for learning experiences. She says

> The objectives described as acquisition of knowledge--the concepts, ideas, and facts to be learned--can be implemented by the selection of content. On the other hand, the attainment of objectives such as thinking, skills and attitudes cannot be implemented by selection and organization of content alone. To attain them students need to undergo certain experiences which give them an opportunity to practice the desired behavior.[8]

In view of this position taken by Taba, it appears desirable, in developing a curriculum to implement both knowledge and process objectives, that a distinction be made between content and learning experiences. The position taken in this study is that such a recognition should be made and that both the content and learning experiences be selected and developed in such a manner as to reinforce the learning which each is designed to accomplish.

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[8]Taba, op. cit., p. 266.

The content and learning experiences to be included in the science curriculum should be selected in such a way as to provide forthe attainment of the objectives established for science instruction. Therefore, the criteria for the development of the content and learning experiences should be consistent with those established for the validity of the objectives for science instruction. Since the educational problems to be faced in a developing country are complex and often unique to a given nation, a somewhat detailed discussion is presented relative to certain of the criteria suggested in this study for the selection of the content and learning experiences for the elementary science curriculum in Iran. The present model suggests that the science curriculum committee should have the responsibility for the selection and development of the content and learning experiences and that the following criteria may serve as guidelines for their deliberations.

1. The content (facts, concepts, principles, and conceptual schemes) should meet, in so far as it is possible, the individual needs of all the children in the nation and also the societal needs for them to become effective citizens.

2. The content should be scientifically accurate.

3. The content, at each grade level, should correlate with the past experiences and the physical and mental development of the children in order to provide for a sequential development of concepts which will make for continuity of study through the elementary grades.

4. The content should be of such a nature that learning experiences may be set which provide for inquiry or discovery learning whereby the children may receive training in acquiring the processes and attitudes inherent in inquiry learning.

5. The content should be of such a nature that learning experiences may be set which provide children with many opportunities for direct contact with objects, situations, and events.

6. The content should be of such a nature that learning experiences may be set which provide for a variety of situations in accordance with children's needs, interests, previous experiences, and maturation.

It is significant to note that the criteria relative to meeting the needs of all the children in the nation is a difficult one to meet and involves many considerations, particularly in a developing country such as Iran. There are several conditions which make decisions regarding the need for specific content areas very difficult. Iran is a very large country with very marked environment conditions due to the various topographical regions and to different climatic conditions. These factors, along with cultural differences and various styles of living, have influenced the present wide differences in the distribution of Iran's population which, in itself, constitutes a serious problem with respect to the content needed to meet the needs of all children. According to the 1966 census, "Iran's urban population totaled 9,800,000 of which 7,200,000 lived in 14 cities of over 100,000, almost 16,000,000 people were village dwellers and nomads.[9] It is also to be noted that while Tehran has a population of over 3,000,000 people, there are about 48,000 villages in the country.[10] The population of most of these villages is very small. To complicate the matter further ". . . reliable estimates placed the number of inhabitants living in tribally organized societies at about 3 million. Most tribesmen are nomadic or seminomadic herders who inhabit the mountainous rims surrounding the central plateau."[11]

The problems created by geographical conditions, varying densities of population, and styles of living were recognized in the government's plans for the reorganization of schools in 1966. One of the principles stated at that time was that

> In building the curricular and determination of the type of schools and their organizations in different regions of the country adequate attention should be devoted to the local economic needs, local traditions and customs, and social and physical conditions of the region.[12]

The problem of providing a science curriculum that would take into account both the needs of the children in populated areas and those in sparsely settled areas has been and is at the present time a most difficult problem. Many valid examples can be made which illustrate the significance of the selection and emphasis

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[9]The New Encyclopedia Britannica, Vol. 9, p. 824.

[10]Encyclopedia Americana, Vol. 15, p. 374.

[11]Harvey H. Smith, Area Handbook for Iran (Washington, D. C.: U. S. Government Printing Office, 1971), p. 121.

[12]Ministry of Education, Educational Aims and the New System of Education in Iran, Department of Planning and Research Publication, No. 57 (Tehran, 1968), p. 5.

which should be taken in attempting to meet the needs of children in different parts of the country. For example, children in populated areas where the water supply is free from disease producing organisms would not necessarily need the same kind of content as the children who live in areas where the water is obtained from rivers and/or wells exposed to surface drainage and other sources of pollution. Preparation of food, waste disposal, and general principles of cleanliness and sanitation are likewise topics that would vary with different modes of living.

In view of this problem, the following recommendations are made relative to decisions involved in meeting the content needs of all the children in Iran.

Recommendation 2. The science curriculum committee should determine the science content which they consider all children should have as the basic knowledge for understanding the environment and for their growth toward effective citizenship. This recommendation is based on the assumption that, in Iran, a national science curriculum for the elementary schools is desirable and the most efficient plan for the improvement of science instruction in the country. It is also based on the assumption that there are identifiable content areas that can contribute essential knowledge toward meeting some of the general needs of all children.

The following are suggested science content areas which the author believes would be desirable for meeting many of the common needs of children.

The area of living things. Various studies and personal observations indicate that children are curious and interested in life about them. Selected facts and concepts in this area can contribute to not only a child's factual knowledge about specific organisms--plants and animals and the life processes, but also to his understanding and appreciation of the interrelationships that exist in nature and to his own understanding of how living things are important to his own life for such things as food and clothing products.

The area of environment. This area of study offers many facts and concepts that apply to the common needs of children. The need for pure air and water, for conserving wildlife, soil, and natural resources, for maintaining balances in nature, for good agricultural practices essential for the production of food and other products, and for having home and community environments which are conducive to healthy living.

The area of health. The needs of children in this area relate to both their physical and mental health. Children need to know about their own bodies and the things that contribute to their growth and to the maintenance of a healthy body. The need to know the causes of diseases and to develop accurate beliefs as to the treatment of illnesses of various kinds can be satisfied through study in this area.

The area of matter and energy. This area could provide children with the basic concepts and principles needed for their understanding of such things as the make-up of matter, the elements and compounds that constitute both living and nonliving things, physical and chemical changes, and natural phenomena of many kinds. Subdivisions for study in this area could include weather and climate, magnetism and electricity, and the use of energy in transportation, communication, and modern machines designed for industrial, commercial, or agricultural purposes.

The area of the universe. There are many facts and concepts in this area which have potential for meeting children's needs to understand such things as day and night, the seasons, the sun as the earth's direct source of energy, and the nature of the solar system and of the stars and other bodies to be observed in the sky.

These suggested areas are likewise suitable for developing learning experiences which would meet the criteria previously cited. Learning experiences in each area could be set for inquiry or discovery learning by which children could make direct observations of objects, situations, and events. Each area is also so extensive in scope as to provide a wide variety of learning activities which could meet the interests and previous experiences of the children. The potential opportunities in these areas for giving children training in such process skills as classifying, inferring, predicting, formulating hypotheses, and testing hypotheses through experimenting are unlimited.

Recommendation 3. After the content areas have been chosen by the curriculum development committee, there should be formed separate sub-committees according to the selected content subject areas. In the model presented in this study, there would be the following designated sub-committees: living things, environment, health, matter and energy, and universe.

The model proposes the following recommendations with respect to the responsibilities and activities of each of the sub-committees.

1. The responsibility for producing the content and the learning experiences in a sequential development for grades one through five. That is, each committee would either create new textbooks or re-write existing materials or make selections and/or adaptations from science curricula which they consider suitable in a new science curriculum for the elementary schools in Iran.

2. The responsibility for establishing the content which would be considered the minimum essentials for implementation in all the elementary schools in Iran and also for the development of supplementary materials to serve the needs of specific elementary schools.

3. The responsibility for developing the evaluative experiences for the textual materials.

4. The responsibility for the materials to be included in the teacher's manuals for each grade level relative to the concepts to be taught and the ways for implementing the learning exercises. Each sub-committee should also be responsible for the science content to be included in the manuals as well as answers for problems and questions.

In the development of the sequential units for each grade level, the following general guidelines are suggested.

1. The formulation of behavioral objectives.

2. The selection of the concepts to be taught in the unit as a basis for the subsequent materials.

3. The instructional materials needed for implementing the lessons in the unit.

4. The teaching procedures to be followed including the ways to motivate the children and the learning exercises to be given the children.

5. The appraisal exercises for the particular lesson or unit.

Recommendation 4. The materials developed by the subcommittees be incorporated into a new science textbook series for the elementary schools of Iran.

Elementary science curriculum component: teaching procedures. One of the significant points-of-view that is repeatedly found in the literature on teaching science is that there is no one best method for teaching science. The implication in this statement is that effective science teaching may be achieved by various approaches. However, the literature does show that just reading about science or the teaching of science through mere verbalization is not conducive to the attainment of the modern objectives for science at the elementary level.

One of the needs for this study was the observation that in actual practice in Iran the instruction procedure was basically that of assign, read, and recite. This approach makes for a climate in which the pupils are passive participants with little or no opportunity to receive training in the processes of science. In view of the need to change the instruction procedures the following recommendations are made for the consideration of the sub-committees responsible for the development of the content and learning experiences of the respective selected areas of study.

Recommendation 1. Each sub-committee attempt, in so far as it is considered feasible, to follow an organizational format that will emphasize an inquiry or discovery approach for the learning activities that are included in the lessons for the units at each grade level. This recommendation infers that the classroom climate will be child-centered with the pupils engaging in activities that involve the direct observing and handling of objects and in experiences whereby they find out for themselves some facts and concepts through inductive and trial-and-error procedures. In making this recommendation, the author does not contend that all learning should be through pupil discovery, but that this approach can contribute to the attainment of the processes and attitudes of science.

The characteristics and advantages of inquiry or discovery learning have been treated rather extensively in Chapter IV. The desirability of adequate instructional materials for the implementation of inquiry or discovery learning is treated in the next component of the model-instructional materials including audiovisual aids.

In developing the format for the units, it could be useful for teachers if attention were given by the writing teams to the type of class grouping needed for the handling of both the content and the learning activities. With respect to this matter, Gerlach and Ely say

> One way of proceeding toward the management of the learning process is to ask the following questions after objectives have been specified.
> 1. Which objectives can be reached by the learner on his own?
> 2. Which objectives can be achieved through interaction among the learners themselves?
> 3. Which objectives can be achieved through formal presentation by the teacher and through interaction between the learner and the teacher?
>
> Answers to these questions will provide useful data for determining how groups should be organized. Some objectives which can be reached independently by the learner should be implemented through the use of the independent study mode. Others require interaction, they demand the use of small groups, finally, some objectives can best be attained through formal presentation; large group sections will be organized for these.[13]

Recommendation 2. A special "teacher manual committee" be formed consisting of one individual from each of the area sub-committees and selected individuals for the preparation of the teacher manuals grades one through five. It is suggested that the "teacher manual committee" have the responsibility for writing the general comments, for explaining teaching procedures, for indicating time allotments, and for correlating the subject matter concepts and factual material produced by the sub-committees for the manual. This recommendation is based on the finding that the people responsible for the development of the new science curriculum programs in the United States of America have advocated the

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[13]Vernon S. Gerlach and Donald P. Ely, Teaching and Media (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971), p. 234.

need to train both pre-and inservice teachers in the use of the respective curricula. This need is even more marked in Iran where the preparation of teachers has not previously included an emphasis on scientific content or methodology. For the successful implementation of a new science curriculum for the elementary schools in Iran, teachers must themselves be knowledgeable of modern instructional techniques. The following information, points-of-view, and/or guidelines are suggested relative to general comments which could be useful to teachers in the implementation of a new science curriculum.

It seems obvious that there should be a rather complete coverage in the manual relative to the various processes and attitudes that characterize inquiry or discovery learning. Teachers must have an adequate understanding of these characteristics in order to implement them in the classroom. It would also be advisable to cite the process or processes to be stressed in each learning exercise and the ways to teach the exercise in order to give pupils training in the particular process.

The manuals should also contain some teacher background factual information in order for teachers to build their own self-confidence in directing pupil learning. It is unreasonable to assume that elementary teachers can ever receive adequate preparation in science in their academic preparation to become teachers, therefore, means should be provided whereby they may continue to learn in the teaching situation. It is suggested, as noted previously, that the preparation of this material for each subject area be the responsibility of the respective area sub-committees.

There should be a section in the manual with respect to learning and the principles of learning which have direct application to teaching. Relevant information concerning this aspect of such a manual have been presented previously in Chapter IV.

Another general feature of the manuals should be some suggestions relative to class organization and individualization of instruction. While it is to be recognized that class sizes will vary widely and that school facilities will not be the same throughout the country, the author feels that efforts should be made to inform teachers of various ways to organize classroom work and of the importance of attempting, whenever feasible, to individualize instruction. Since these two aspects of teaching have not been covered previously in this study, the following treatment is presented as background material.

Educators in all countries have indicated the need for as much individualization of instruction as it is possible to provide. It is widely recognized that children differ in intellectual abilities, interests, previous experiences, and numerous other factors which affect learning. All children do not learn at the same rates and even the same child may achieve at different rates in different tasks. Kuslan and Stone say that

> . . . these differences affect both the teaching and the learning process and for this reason rigid, group lockstep instruction in science is an invitation to mediocrity. The wise teacher knows that no single instructional method--

> whether it is inquiry, recitation, or programmed learing--is sufficient to sustain interest, to develop cognitive skill, and to maintain "The responsive environment" that nurtures learning.[14]

There is need for differential instruction for the very intellectually gifted and the "so-called slow learner." One suggestion offered by Thomas and Thomas[15] for caring for the gifted is to place them in special classes where they can proceed at their own rates or to assign such individuals to specific group projects where they will work together. Either of these methods has disadvantages and no completely satisfactory procedure has been found for the usual classroom. There is some evidence to show that field trips, visits to farms and zoos, and the building and care of aquaria and terraria have appeal for the less verbal pupils. Thomas and Thomas contend that particular attention should be given to the slow learner in health and safety. They say

> The retarded learner's need for training in health and safety practices is often very great. Because of his intellectual limitations, he may not pick up health and safety information outside of class as readily as his more average classmates. Hence he needs to be taught these things directly.[16]

While classroom procedures will probably continue to be organized and implemented through some kind of grouping, teachers should be cognizant of the need for and the advantages which are

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[14]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach, 2nd ed. (Belmont, California: Wadsworth Publishing Co., 1972), pp. 65-66.

[15]R. Murray Thomas and Shirley M. Thomas, Individual Differences in the Classroom (New York: David McKay Company, Inc., 1965), p. 233.

[16]Ibid., p. 293.

inherent in individualizing instruction. Two of the advantages cited for such instruction are:

1. It recognizes the individuality of children and provides situations whereby they may progress at their own rates of accomplishment. This is an advantage over the usual group work in that slow pupils are not pressured to work beyond their normal rates and bright pupils are not held back because of the slow progress of others. This method recognizes the emotional, mental, physical, and social differences that may exist in children and attempts to give cognizance to the things in the tasks assigned to children.

2. It provides meaningful and obtainable experiences in accord with such factors as the abilities, needs, interests, and previous experiences of the individual children. Since such experiences are designed to be meaningful and obtainable they contribute to the child's confidence and satisfaction in having achieved the objectives of the experiences. It is claimed by some that such instruction is more effective than traditional group instruction in stimulating interest and in providing experiences that challenge pupils.

Teachers also need to recognize that there are different ways to implement instruction in the usual classroom setting other than total group instruction. Groups may be organized by ability, by interest, or some other criterion. While ability grouping according to some criterion, such as scores on intelligence or achievement tests has been widely practiced, it is worth noting that according to Eash

> Ability grouping in itself does not produce improved achievement in children. Improved achievement seems rather to result from the manipulation of other complex factors: curriculum adaptation, teaching methods, materials, ability of the teacher to relate to children and other subtle variables.[17]

One advantage of ability grouping is that pupils would at least have the potential for achieving with respect to the difficulty of the assigned tasks. Interest grouping has been found to be effective particularly in specific area or project tasks. The point that is significant is that some objectives may be better achieved through specific types of groups--whether large groups or small groups--and teachers should modify their organizational plans accordingly.

It is advisable that a teacher manual should contain instruction for teachers concerning the use of equipment. For example, if microscopes are to be used, experience has shown that many elementary teachers do not know how to accurately focus such an instrument or to handle and care for it properly. Teachers unquestionabley need instruction in the use of certain audiovisual aids and such instruction should be provided in the manual or in a special audiovisual instruction manual. Suggestions should be given as to things that children could secure from their own environments or make themselves.

Heiss says that

> . . . many science teachers feel that often the homemade piece has greater potentialities for educating than the

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[17]Maurice J. Eash, "Grouping: What Have We Learned," Grouping in the Elementary School, ed: Anne Morgenstern (New York: Pitman Publishing Company, 1966), pp. 90-91.

> purchased equipment because the pupil may be a participant in the actual making . . . there are many, many simple devices which may be made by pupils from tin cans, cigar boxes, electric light bulbs, scrap metal, and wire.[18]

Suggestions should also be made as to safety measures that need to be taken in using certain chemicals and even in the use of simple tools. Teachers should be aware that children are often prone to place foreign objects such as beans, chalk, etc., in either their ears, nose, or mouth and precautions should be taken to see that such action does not occur.

Some suggestions should be made as to activities or classroom situations that may not be provided for in the textbooks. Attention should be given to the worthwhile uses that can be made of bulletin boards. Gega[19] says that bulletin boards are effective for creating interest in introducing new units, for emphasizing specific features, and for summarizing ideas. The science corner likewise offers a means for stimulating pupil interest and learning. Such a corner can contain books, magazines, displays of various kinds and facilities where children could work independently on activities of their own choosing. If space were available, a center-of-interest corner could be used not only for science, but for any of the subjects taught in the elementary school. There should also be comments as to the advantages of field trips and excursions. According to Piltz

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[18]Elwood D. Heiss, et al., Modern Science Teaching (New York: The MacMillian Company, 1950), p. 275.

[19]Peter C. Gega, Science in Elementary Education (New York: John Wiley and Sons, Inc., 1970), pp. 110-113.

> Field trips or excursions may provide some of the most stimulating learning activity in science. They afford the pupils an opportunity for direct observation and a view of plant and animal ecology impossible in a classroom situation.[20]

It would also be advisable to include directives as to procedures for planning and carrying out field trips. Some suggestions concerning collections, and making such things as flannel boards, displays, aquaria, and terraria could provide teachers with ideas for enrichment activities.

Another general feature of the manuals should be suggestions concerning the evaluation of the pupils. Comments should be directed at different ways a teacher may collect valid evidence as to the degree of pupil achievement of the specific objectives of given lessons and units and of the general objectives of science instruction. Comments and suggestions regarding information which could be used in this part of the manual are made later in the evaluation component of this study.

In addition to the general topics cited above, suggestions should be offered as to sequence of units and the time needed to adequately cover lessons. The subject matter concepts and other materials produced by each sub-committee should be so organized as to provide clear directives to the teachers and include answers to questions and explanations for the situations or events being studied by the pupils.

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[20]U. S., Department of Health, Education and Welfare, Office of Education, Albert Piltz, Equipment and Materials for Elementary Schools, Bulletin No. 28, p. 39.

It is recognized that the suggestions made regarding the development of teacher manuals has been extensive and on first examination may appear to include things that teachers should already know. However, the author believes that most elementary teachers in Iran need such information in order to adequately implement the new science curriculum which could emerge from the recommendations made in the model presented in this study.

Elementary science curriculum component: instructional materials including audiovisual aids. In developing a model for a science curriculum for the elementary schools of Iran, it has been recommended that a new series of textbooks be developed for the use in all the elementary schools in Iran. These texts should constitute the primary instructional materials for all schools. It has further been suggested that the texts be written in such a manner that they contain not only factual and/or conceptual scientific information, but that they contain activities, experiments, and exercises that are considered psychologically sound with respect to present knowledge as to how children learn. The discussion and recommendations which follow are limited to other instructional materials than texts. However, it is to be emphasized that in the present model for the development of a science curriculum, other instructional materials, as well as texts, are considered an essential feature of the model.

The basic concept in the present model regarding the teaching of science is that the pupils should have, whenever it is feasible, direct experiences with concrete objects and/or situations. There are many published comments, as previously mentioned in this thesis, that support this point-of-view. The UNESCO Source Book for science teaching contains the following statement

> . . . Science . . . is not effectively learned by children unless they experience it. It is not sufficient to hear about science or to read about it. Children must observe and experiment if their science learnings are to be permanent.[21]

This quotation implies that children in order to gain meaningful explanations of scientific concepts must have the opportunity to examine first hand the actual objects and/or phenomena being studied. They should have situations in which they can observe through the various senses the actual objects and situations. They need concrete instructional materials whereby they can form conclusions for themselves on the basis of their own observations rather than accept without evidence a teacher's verbalization of objects, things, concepts, or scientific phenomena. In order to provide information that would be useful to the administrative unit responsible for instructional materials, the following recommendations are made.

Recommendation 1. Each subject matter sub-committee in the preparation of the units for each grade should prepare a list of the instructional materials that would be needed for the implementation of the exercises, experiments, and activities contained in each lesson in the units produced.

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[21]United Nations Educational, Scientific and Cultural Organization, UNESCO Source Book for Science Teaching, 1956, p. 29.

In regards to this recommendation, the members of the sub-committees should give due cognizance to developing activities, experiments, and exercises that are designed basically to use equipment and/or supplies that are easily obtained, safe for children to use, and that do not require complicated equipment. With respect to criteria for the selection of equipment, the following questions are cited by Kuslan and Stone as guides for decision making relative to the purchasing of equipment.

1. Is the apparatus or supply functional? Does it perform according to its specifications?
2. Is its expense justified by its potential uses?
3. Is it safe?
4. Is it durable, reliable, and uncomplicated? Will it work with a minimum of maintenance? Is repair likely to be expensive and time-wasting? Can it be repaired locally?
5. Will children who sit at the rear of the room be able to see the important details? Is it large enough so that children can manipulate it?
6. Are there less expensive substitutes?
7. Is it a "black box" instrument, whose internal operation is hidden from the class? Is it too advanced, too complex for the class?
8. Is it easy to store?
9. Are operating directions easy to follow?
10. Does it have potential for different kinds of learning experiences, or is it more limited? If it is not versatile, is it indispensable for its intended purpose?[22]

The list of supplies should include in addition to those which would need to be purchased commercially those that it would be feasible for children to bring to class or which the teacher could secure locally.

Recommendation 2. The equipment and supplies needed for the lessons in the units developed in each subject matter area at each

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[22]Kuslan and Stone, op. cit., pp. 369-70.

grade level be purchased and assembled centrally as a complete teaching package similar to the way the Science Curriculum Improvement Study was done with the materials needed for the implementation of that program. It is suggested that the responsibility for implementing this recommendation be assumed by the present organizational division in the Ministry of Education which is concerned with instructional materials.

This recommendation is a very significant one if the new science curriculum is to be implemented effectively because pupils must have the necessary instructional materials in order to receive the experiences for the attainment of the objectives for science in the elementary schools in Iran. Therefore, there must be a central administrative unit to finance the necessary purchases, to prepare the packages, and to control their distribution and replacement.

The remainder of this component of the model is concerned with audiovisual aids. Many educators feel that a modern and effective educational media program is essential to the implementation of a well conceived science curriculum for the elementary schools. Research in the effectiveness of various instructional techniques has shown that audiovisual methods have some distinct advantages. For example, it has been found that, in general, one learns more easily and faster through audiovisual techniques than by verbal explanations alone. Research also supports the conclusion that audiovisual methods appear to facilitate the acquisition, retention, and the recall of the facts and concepts inherent in many learning situations.

While one of the basic ideas in the present model is that children should have as many direct experiences as possible with concrete objects, things, and situations, it is to be recognized that there are many worthwhile experiences for which direct pupil contact cannot be provided in the classroom. Kuslan and Stone have pointed out that

> One of the most important reasons for using audiovisual materials in the elementary school instruction is to help the children to become familiar with content not directly at hand. Audiovisual aids are therefore a substitute for direct experience.[23]

Pictures, film strips, motion pictures, and educational television can provide instructional materials and experiences which otherwise would be unattainable to the vast majority of the elementary school children in Iran. Not only can such media provide children with information concerning specific living things, their habitats, and the interrelationships of living things, but they are useful in developing an understanding of agricultural practices, industrial developments, the need for social and economic improvements, and the conditions that are necessary to lessen disease and which contribute to healthful living conditions. Educational media can contribute to a better understanding of one's own country and can also furnish information relevant to the things that exist and that are going on in the world at large.

In order for an educational media program to be well conceived and effectively implemented, Brown says that

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[23]Kuslan and Stone, op. cit., p. 344.

> . . . Contemporary education requires a systematically administered and technologically oriented media program that is considerably more than a simple combination of library and audiovisual resources. The key to this approach is not found in merely bringing together various educational media services under a new organizational title; it lies in the effective integration of those services with the processes of planning and implementing the entire instructional program. And what is therefore required, under this latter condition, is that media resources be viewed, at the very outset, as integral elements of curriculum development and instruction and that there be direct and continuous involvement of media professionals with teachers, curriculum and subject matter specialists, students, and others in designing, testing, and implementing such programs.[24]

These statements by Brown are directly applicable to the development of a science curriculum for the elementary schools in Iran in that an adequate educational media program should be an integral part of the science curriculum and should be developed along with the science curriculum.

It is significant to note that while the science curriculum program as presented in the present model is designed as a national science curriculum, there are many reasons for flexibility and local adaptability in implementing the program. Iran is a large country with very diverse natural and socio-economic conditions and, as with science content materials, there is a need for audiovisual materials that may best serve the needs and objectives of given schools whether in densely populated areas or in the villages. Levie and Dickie say that

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[24]James W. Brown, Administering Educational Media (New York: McGraw Hill Book Company, 1972), p. 1.

> . . . a basic postulate for a technology of media selection is that the nature of the learning task and the nature of the objectives associated with a unit of instruction should be determinants of the medium used to provide the instruction.[25]

In order to make appropriate selections and use of audiovisual materials, schools need to have resource centers from which they may secure materials, equipment, and/or plans for the collection or preparation of various types of educational media that best facilitate the learning of specific content materials. The resources which should be available should include such aids, and the equipment necessary for their use, as: films, film strips, slides, motion pictures, still pictures, graphic representations including charts, illustrated diagrams, and overlays, models, and various simulation materials.

It is the author's opinion that, in the development of the model for the science curriculum for the elementary schools of Iran, a correlated educational media program should be conceived and implemented as an integral part of the model. The following recommendations and comments are presented as points-of-view to be considered as means for best serving the purposes of the model and thereby contributing to the improvement of elementary science instruction in Iran.

Recommendation 1. The functions and responsibilities of the present media department of the Ministry should be enlarged to

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[25] W. Howard Levie and Kenneth E. Dickie, "The Analysis and Application of Media." Second Handbook of Research on Teaching, ed: Robert M. W. Travers (Chigago: Rand McNally and Company, 1973), p. 859.

include active participation in the procedures followed in the development of a new science curriculum. It is assumed that at least one of the staff would be a media specialist who would also be well qualified in the sciences. Such a person would be able to make contributions to the selection and/or development of instructional materials and techniques designed to facilitate the achievement of the overall and specific objectives of the science program. It is further assumed that media division would have the responsibility for the development and implementation of administrative practices which would correlate and service the science audiovisual needs of the various educational offices, districts, and/or schools throughout the country. It is also assumed that the necessary monies would be allocated to the division for the purchase and/or development of the needed audiovisual aids.

Recommendation 2. Additional administrative policies should be developed which would provide channels for improving the existing audiovisual centers at the offices of education in Ostans, Shahrestans, and districts and for establishing, upon the basis of valid criteria, new audiovisual centers where needed. Guidelines should be developed concerning the functions of the centers. In addition to serving as dispositories for resource materials and equipment, centers in Ostans and Shahrestans could be concerned with the preparation of pictures, slides, and other relatively inexpensive and easy to prepare materials. It is further recommended that each center be staffed, if at all possible, by at least one person who would have the responsibility for not only meeting the requests of schools for audiovisual aids but who would also give active leadership to the schools as to the means and ways by which educational media may facilitate and enrich the learning experiences of children. In some situations, this function could be achieved by inservice workshops for teachers.

Recommendation 3. Administrative policies should be established for the handling of audiovisual aids in each school regardless of the size or geographical location of the schools. In larger schools, it might be advisable to have a full time staff member handle all the details associated with audiovisual instruction including actual assistance to teachers in the use of various audiovisual equipment. Procedures should be established whereby the facilities of the program could be available to the village schools. This responsibility could be one of the functions of a supervisor or a part time assignment for a teacher in a village school.

Elementary science curriculum component: pupil evaluation. In the present model, evaluation techniques are considered an integral part of the development of a new science curriculum. There are several reasons for taking this position. One basic reason is that with a new curriculum there will be new objectives and since these objectives include other attributes than the acquisition of knowledge *per se*, evaluation instruments or techniques are needed to appraise pupil attainment of these other attributes, such as the ability to observe accurately, to recognize opinion from fact, and to solve problems. Another reason is that evaluation should be considered as a continuous process along with other teaching skills and procedures. A third reason for holding to the belief that evaluation techniques should be developed as a part of a new science curriculum is the need to assist teachers in their efforts to evaluate pupil progress toward defined goals. In view of these reasons and others to be discussed later, the following recommendations are made.

Recommendation 1. The science development sub-committees prepare as an integral part of the respective subject areas evaluation exercises for the lessons and units to be developed at each grade level. These evaluation exercises, in the author's opinion, should at the lower grades be designed as suggestions for teachers to use in implementing the new curriculum and should be placed in the teacher manuals. At the grades where children can be expected to read and to follow instructions these exercises should be an integral part of the textual materials.

In preparing such exercises there are several things to be considered. Traditionally evaluation instruments were designed basically to measure an individual's ability to recall or to recognize the facts, concepts, and conceptual schemes to which the individual had been exposed. To many present day educators, there is still a need for such instruments as the acquisition of cognitive objectives is held to be one of the goals of education.

However, most educators also contend that evaluation should be concerned with assessing a pupil's growth toward the attainment of other goals which may not be measured very effectively by traditional evaluation instruments. Thus, there is a need for appraisal exercises designed to assess a pupil's ability to not only recall and recognize facts, but to also assess a pupil's ability or skill to perform the process which characterize inquiry or discovery learning and to ascertain the acquisition of desirable attitudes, interests, and appreciations.

Recommendation 2. The teacher manuals include a treatment of the modern concepts and purposes of evaluation.

While it is to be recognized that teachers will need to evaluate a pupil's progress in order to serve as a means for grade promotion, administrative records, and reporting to parents, they should be familiar with other purposes and uses of evaluation techniques. They should be familiar with the different kinds of tests and exercises, their construction, and the uses which can be made of them. Evaluation, in its modern interpretation is a very important and significant feature of instruction. It is also a very difficult task since there are so many variables that operate in the teaching and learning situations.

Suggestions should be made as to the employment of tests and other evaluative techniques. This is a particularly troublesome problem at the elementary level since the usual types of pencil and paper instruments cannot be used until children are able to read and write and one is faced with decisions as how to evaluate effectively when this is the general situation.

Teachers need suggestions as to the functions and use of formal and informal evaluation techniques. Informal evaluation should be an integral feature of daily instruction and is used in assessing the behavioral objectives for a given lesson or in subjective evaluation of pupil attitudes, interests, and appreciations. Formal evaluation may be accomplished by two kinds of measurement--paper and pencil tests or situation techniques. Teachers need assistance in how to construct valid tests. Ebel says that "The validity of most classroom tests is a matter of carefully defining what is to be measured, and of relying on expert judgment to determine how well the tests measures it."[26] Teachers need to know exactly what is to be measured. They also need to be familiar with and how to construct such objective tests as the short-answer, true-false, multiple choice, matching, and picture tests. If teachers are to evaluate effective behavioral objectives, they will also need some suggestions for using situation techniques. Such a situation ". . . is the systematic observation of the performance of the individual child in a situation where he is asked to respond in a specified manner when presented with an appropriate set of materials."[27] This technique has been used successfully with Science--A Process Approach in the United States of America.

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[26] Robert L. Ebel, Essentials of Educational Measurement (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972), p. 436.

[27] Ronald D. Anderson, et. al., Developing Children's Thinking Through Science (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), p. 285.

It needs to be emphasized to teachers that tests and other evaluative techniques may be used effectively for other things than assigning a grade. They may be used to diagnose pupil weaknesses, to ascertain whether or not a lesson should be re-studied or where emphasis should be given in a specific lesson, to serve as feedback for pupils in order for them to learn to assess their own needs and accomplishments, and to provide information relative to teacher decisions as to future work. Evaluation includes not only decisions about children, but also about the total teaching situation. With respect to his idea, Kuslan and Stone say

> Teaching as an art form, calls for making decisions. For instance the teacher must decide whether this class is ready for an experimental sequence on electricity, whether sufficient resources are available and whether electricity is a better subject for study at this time than insect life.[28]

One may infer from the above quotation that it is desirable, in view of pupil progress or vaying environmental conditions such as those that exist in Iran, to use good judgment in the selection of the sequence of units, rather than to follow a prescribed schedule without any flexibility. Thus, suggestions as to means for providing flexibility could be a useful aid to teachers in their efforts to meet the needs and interests of the children in specific enviornmental settings. In summary, teachers need to have assistance in the area of evaluation and the inclusion of such material in the teacher manuals is essential to the effective implementation of the model proposed in this study if the goals of a modern science curriculum are to be achieved.

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[28]Kuslan and Stone, op. cit., pp. 388-9.

Recommendation 3. The Department of Planning and Research in the Ministry of Education be represented on the Science Curriculum Development Committee and that it assume the responsibility for the development and implementation of the evaluation techniques and procedures which have national application. These techniques and procedures, as proposed in the present model, would be:

1. The preparation of the general information in the teacher manuals relative to modern concepts of evaluation in the elementary school.

2. The development of standardized tests for appropriate grade levels.

3. The establishment of procedures and policies for administration of tests.

A rationale for the preparation of materials for the teacher manuals has been given in the previous section. The development of standardized instruments and the establishment of procedures and policies for administrative purposes are needed in Iran where all children will study the same basic science and where schools are so widely distributed due to the size of the country. While consideration should be given to the place of teacher evaluation and to the standards that might be expected in different schools due to size of school, available teaching facilities, and quality of instruction, such efforts at standardization, if used wisely, could provide a means to at least determine minimum standards of achievement and could also indirectly give some indication of the effectiveness of the teaching that is being done in the various schools. Since the country is large and the government's administrative units are often widely separated, there is need for evaluation policies which would be applicable to all parts of the country. The establishment of such policies appears essential for the effective implementation of a national science curriculum.

Elementary science curriculum component: teacher training. One of the conclusions pertaining to the implementation of the new science curricula in the United States of America and other countries is that teachers, both those already teaching and preservice teachers, need training in the implementation of the new curriculum programs whether it be S.A.P.A., E.S.S., S.C.I.S. or any other of the new programs. Some of the efforts to prepare individuals to be more effective elementary and secondary science teachers in the United States has been presented in Chapter III. A brief review of additional information concerning teacher education follows.

The literature indicates that few experimental studies in the area of teacher education have been done in the United States from which warranted conclusions may be made. Peck and Tucker report that

> In surveying . . . the journals, books, dissertation abstracts and final reports of contract research which constitute the literature for the period 1955-1971, we found all too many examples, still of inadequate research design or inadequate reporting.[29]

They state further that a reason for this finding

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[29]Robert F. Peck and James A. Tucker, "Research on Teacher Education," Second Handbook of Research on Teaching, ed.: Robert M. W. Travers (Chicago: Rand McNally Company, 1973), pp. 940-41.

> . . . is the inherently complex nature of the phenomenon to be studied. "Teacher education" is a long complicated series of operations. Each operation is, itself, an extremely complex set of steps most of which have never been carefully identified, let alone measured.[30]

The same authors report that a study of Breit and Butts (1969) in which instruction in Science--A Process Approach was provided a group of teachers that

> . . . the teachers receiving this training significantly increased in their knowledge of the processes of science. They also improved their instructional decision making behavior by comparison with control samples who did not receive the instruction.[31]

Peck and Tucker also reported that

> Greif (1961) found that specifying and emphasizing the desirability of fostering creative and critical thinking in educational methods courses and in student teaching, produced highly significant gains in the students' ability to think critically, and to think creatively and to implement such thinking in their pupils.[32]

While there appears to be a lack of experimental research evidence concerning the relationship between teacher education programs (including both content subject matter courses and methods courses) and teacher effectiveness in the classroom, these two studies add support to the belief that it is desirable for teachers to have training in the processes and skills which they are expected to implement in the classroom.

As a matter of general interest, it is to be noted that in the United States, there is no uniform pattern for teacher education.

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[30] Ibid., p. 942.

[31] Ibid., p. 944.

[32] Ibid.

However, Hicks and Blackington after reviewing reports of state, regional and national commissions and studies of developed programs in Colleges and Universities dealing with the education of teachers concluded that there were four basic principles which appeard to be the guidelines for the preparation of teachers. These principles were:

1. Broad cultural education.
2. Thorough knowledge of subject matter.
3. Understanding of basic philosophies of education.
4. Professional preparation.[33]

While there are differences of opinion as to the emphasis which should be placed on these various principles or guidelines, there are many educators in the United States that feel that "student teaching," which is often considered a part of the professional preparation of teachers, is perhaps the most important aspect of teacher education. This point-of-view is expressed by Hunter and Amidon in that they say "It may well be that student teaching is the single most important experience in teacher education in terms of influencing the classroom behavior of future teachers."[34]

In-service education is another feature of education in the United States that is receiving attention. The Fifty-sixth Yearbook of the National Society for the Study of Education cites the following reasons for in-service education.

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[33]William Vernon Hicks and Frank H. Blackington III, Introduction to Education (Columbus, Ohio: Charles E. Merrill Books, Inc., 1965), pp. 152-157.

[34]Elizabeth Hunter and Edmund Amidon, "Direct Experience in Teacher Education: Innovation and Experimentation," The Journal of Teacher Education XVII, 3 (Fall, 1966): 282.

1. To promote the continuous improvement of the total professional staff of the school system . . .
2. Continuous in-service education is needed to keep the profession abreast of new knowledge and to release creative abilities . . . .
3. To eliminate deficiencies in the background preparation of teachers and of other professional workers in education . . . .[35]

The significance and importance of in-service education to curriculum change is shown in Moffitt's statement that

> With all that has been written and discussed about continuous expansions and alterations of the curriculum, it must be understood that the curriculum changes only as the teacher changes it.[36]

The implication is clear from this statement that teachers must be knowledgeable about a new curriculum if the new curriculum is to be effectively implemented.

In addition to the efforts to prepare teachers to become better science teachers as cited in Chapter III, a publication was produced in 1969 by the A.A.A.S. Commission on Science Education entitled Pre-service Science Education of Elementary School Teachers. This publication made recommendations for the pre-service education of teachers in relationships to the recent developments in science and attempted to define the things which elementary teachers should be able to do. One of the main views expressed was that science for elementary teachers should be taught in the same

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[35]C. Glen Hass, "In-service Education for Teachers, Supervisors, and Administrators," in The Fifty-sixth Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1957), pp. 13-14.

[36]John Clifton Moffitt, In-service Education for Teachers (New York: The Center for Applied Research in Education, Inc., 1963), p. 12.

style of inquiry which is stressed in the new elementary science programs.

The conclusion that may be drawn from the efforts that are being made in the United States regarding the science preparation of elementary teachers is that an individual should be knowledgeable in the subject matter areas and should understand and be able themselves to demonstrate the behaviors which characterize inquiry or discovery learning. In order to provide experiences for acquiring science information attention has been given to the development of new or modification of science and science education courses in colleges and universities and to in-service programs and workshops for teachers and/or supervisors.

In developing the present model for a new science curriculum for the elementary schools in Iran, it is to be recognized that the preparation and certification of teachers is very different from that in the United States and in some countries in Western Europe.

In Iran, the Ministry of Education has jurisdiction over the preparation of teachers for the elementary schools and has established four types of teacher training institutes for teachers in the first cycle of the general education program. These are: the normal schools, the rural teacher training centers, a unique tribal normal school, and the literacy corps teacher centers. In each of these types of training schools or centers some hours are given to experimental science and teaching methods. A limited amount of in-service training has also been conducted by the Ministry of Education.

In considering the need for a new science curriculum with all the positive effects that such a curriculum could have upon the education of the children in Iran, it should be apparent that teachers must be trained to implement the program. The following recommendations are designed to serve as suggestions as to how such training could at least be started under the direction of the Ministry of Education. In presenting these recommendations, the author is well aware that they do not cover all the problems to be faced in attempting to prepare teachers for implementing a new science curriculum. It is recognized that there will be many problems and that there are no simple answers to these problems.

Recommendation 1. The Department of Teacher Training in the Ministry of Education be represented on the Science Development Committee and that the Department assume the responsibility for developing the policies and for implementing such policies relative to the training of elementary teachers to use the new science curriculum. It is further suggested that as a means for providing training for the elementary teachers that the department

1. develop appropriate instructional materials for conducting workshops and in-service programs for implementing the new science curriculum. It is suggested that the instructional procedures provide the participants in the workshops or in in-service programs with direct practice in doing selected exercises from the new science curriculum.

2. provide the personnel for conducting workshops for selected individuals from the present elementary teacher training institutes.

3. provide the personnel for conducting in-service training for the teachers in the schools which may be selected as "trial schools" in the proposed method for evaluation of the model.

Recommendation 2. The workshops for the individuals selected from the present elementary teacher training institutes be limited to not more than twenty-five members and that such workshops be at least two weeks in length.

Recommendation 3. Plans be developed and implemented whereby the individuals presently employed in teaching in the elementary schools throughout the country receive training through in-service programs or workshops in the use of the new science curriculum.

<u>Some further comments, suggestions, and recommendations relative to the development of the science curriculum for the elementary schools in Iran</u>. The developmental work necessary for the decisions related to the component features of this study and the preparation of most of the materials for the science curriculum would rest with the curriculum development committee and its subcommittees. It is essential that the members of the committees be knowledgeable individuals who themselves are committed to the need for improvement in science instruction in the schools in Iran. The tasks involved in the development of a new science curriculum are laborous and time consuming. It has taken several years for the development of most of the new science curriculum projects in the United States and this observation should be recognized in developing the science curriculum for the elementary schools in Iran. The

administrative details necessary for implementing the work of the committees including the necessary financing of these committees, the publishing of texts and manuals, and the securing of instructional materials extend far beyond the scope of this study. It has been assumed in this study that such details would be handled as ongoing operations of the Ministry of Education. The present model, however, does rest upon the work of these committees and the following recommendations are presented as possible guidelines.

Recommendation 1. Writing sessions for the work of the sub-committees be established for periods of four to six weeks in which the members would devote full time to the development of the lessons and units and other associated tasks.

Recommendation 2. The first writing session be devoted to the production of the textual and associated materials for grades one through three. Implicit in this recommendation is that these materials would be forwarded to the proper administrative department in the Ministry of Education for publication. It is further suggested that these first editions be soft-back publications including the teacher manuals which, as proposed in this model would be the responsibility of the "teacher manual committee."

Recommendation 3. A second writing session be devoted to the production of the textual and associated materials for grades four and five. The production of these materials should be handled as noted in Recommendation 2.

Recommendation 4. After the materials have been tried out in "trial schools" writing sessions be held for re-evaluation and re-writing prior to the publication of the final editions of all the materials.

Recommendation 5. All the writing sessions should include, in addition to the members of the sub-committees, representatives of the various units in the Ministry of Education which have assumed the responsibility for developing and/or implementing other facets of the curriculum as recommended in this study.

Elementary science curriculum component: model evaluation. Experience in the United States shows that it is advisable to have new curriculum materials tried out in regular classroom situations before final editions are published. In view of this experience which gave the curriculum writers feedback as to the things that appeared to be suitable and those that needed revision, the following recommendations are presented as means for trying out and securing some tentative opinions as to the effectiveness of the model.

Recommendation 1. The Ministry of Education select "trial schools" for trying out the new science curriculum. It is suggested that these schools be representative of those in densely populated areas and also of those in sparsely populated regions.

Recommendation 2. The teachers in the "trial schools" be given in-service training with the new curriculum materials prior to the use of the materials in the schools.

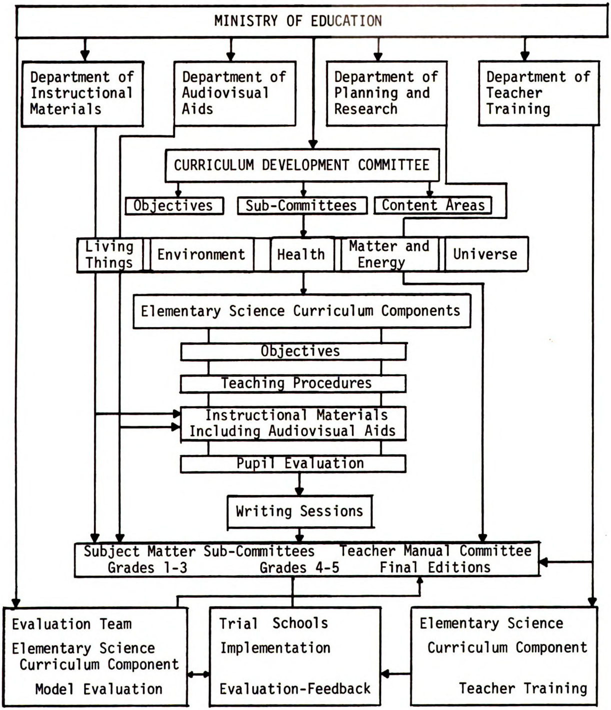
Recommendation 3. The Ministry of Education assign an evaluation team to prepare evaluation forms for teacher evaluation of the effectiveness of the new materials and that this team conduct personal on the site evaluations in the "trial schools."

Recommendation 4. The evaluation team analyze the teacher evaluations and together with their own conclusions prepare a feedback report to the members of the writing sessions prior to the sessions where the final editions are to be produced.

Summary. This chapter has presented in detail the background and the rationale for the basic components of the model for this study and the suggested recommendations pertaining to each component. The following flow chart summaries the suggested operational organization of the model.

Model for the Development and Implementation of a Science Curriculum for the Elementary Schools in Iran

Flow Chart



CHAPTER VI

SUMMARY AND RECOMMENDATIONS

The main purpose of this study was to construct a model for the development and implementation of a science curriculum in the elementary schools in Iran. The need for the study was indicated by the government's continued plans and efforts to improve educational opportunities, the present elementary science curriculum and the methods employed in teaching, and the inherent potential which science instruction has for developing in children desirable patterns of thinking and acting. The model represents a theoretical scheme which was constructed from hypothetical reasoning and empirical information. Thus, the study was designed to collect relevant information and to offer suggestions and recommendations with respect to the component parts of the model which were: science curriculum-objectives and content, teaching procedures, instructional materials including audiovisual aids, pupil evaluation, teacher training, and model evaluation. It was assumed that the model was by design adaptable to and functional within the present organizational pattern of elementary education under the administration of the Ministry of Education.

The Ministry of Education establishes the policies and administers all aspects of elementary education. The Ministry develops the budget, employs teachers, establishes the elementary curriculum, provides for the training of elementary teachers, carries on planning and research, and acts as the directive and coordinating center for elementary education implementation throughout the country. The present pattern of elementary education, grades one through five, provides for the first cycle of the general education program of the country. This primary education is free and compulsory for all children. In the scholastic year 1972-73 there were 3,445,528 pupils enrolled in the regular elementary schools and the Literacy Corps schools. Teachers are prepared in four types of training institutions. In addition to instruction in the established schools in cities, the Literacy Corps are engaged in the rural areas in providing instruction for children and adults and in assisting in local civic undertakings.

The review of literature revealed that science educators in the United States had advocated for many years the teaching of science not only for the acquisition of knowledge but also for developing in children the skills and attitudes by which scientific knowledge is obtained. While such objectives had been emphasized to a more or less degree in the latter part of the nineteenth and the first part of the twentieth centuries, it was not until the late 1950's that concerted efforts were started to develop curricula designed to incorporate and to emphasize both the content (products) of science and the processes which characterize scientific endeavor. Some twenty new science curricula for teaching science have been produced in the last fifteen years. Most of these curriculum programs were developed by teams of scientists, science educators, classroom teachers, and other knowledgeable individuals. Many of the programs were supported financially by the National Science Foundation, the U. S. Office of Education, or private foundations. In addition to the development of textual materials, several of the programs were tried out in selected school systems. Efforts were also made during the curriculum development period to retrain teachers by providing opportunities for selected teachers to secure additional training at colleges or universities in academic science courses and in methods of teaching science. Attention was also given to conducting workshops, in-service programs, and summer institutes for familiarizing teachers with the new science materials at both the elementary and secondary levels of instruction. Examination of the literature also revealed that other countries have been working on curriculum changes in science and several nations have patterned their changes after American programs.

Examination of selected new science curriculum programs in the United States indicated that the two main objectives for science instruction were the acquisition of scientific knowledge (facts, concepts, and conceptual schemes) and of behavioral patterns which indicate a child's ability to use the processes of science. Some of the processes stressed are: observing, describing, classifying, collecting relevant information, formulating hypotheses, testing (experimenting), and drawing valid conclusions. The writers in each of the programs appear to have attempted to select subject matter which they considered suitable for providing children with direct, concrete experiences with the things or situations to be studied. The concept of learning, either stressed or implied, in most programs is to let children learn or discover for themselves. In order to implement this concept, learning exercises were designed to encourage children to observe through their senses concrete objects, things, and situations rather than just read or be told about them by the teacher. The teaching method most frequently stressed, while called or designated differently in various programs, is one characterized by trial and error procedures and inductive reasoning. One much used designation given to this teaching approach is inquiry or discovery learning.

In preparing the model for this study, the author attempted to draw upon the ideas and practices exemplified in the new science curriculum developments in the United States and upon the concepts of learning and teaching used to implement the programs that he considered desirable and workable for developing and implementing a science curriculum for the elementary schools in Iran. The science curriculum, in the present model, was assumed to be all the planned experiences provided by the school to assist pupils in attaining worthwhile goals. Curriculum development was interpreted to mean all the tasks involved in making decisions relative to such planned experiences and to methods of instruction by which the objectives of the curriculum might be attained. As a means for furnishing a working basis for curriculum development, the model includes recommendations as to organizational patterns of operation, to administrative responsibilities, and to the implementation of the curriculum. The study has presented a relative detailed discussion and rationale for each of the component features of the model with accompanying recommendations for each interrelated component. In listing the recommendations which apply to each component of the model, it is to be noted that the pages devoted to the discussion and rationale for that specific component are cited in parentheses as a reference for the interested reader.

Curriculum Development Committee. The formation of a Curriculum Development Committee constitutes the basic unit for the model for the development and implementation of a science curriculum in the elementary schools of Iran. The committee should be formed as an integral body under the administration of the Ministry of Education and the members of the committee selected by the Minister of Education. The committee should be composed of regular staff members, scientists, science educators, educational psychologists, elementary classroom teachers representative of the various geographical locations, evaluation and curriculum specialists, supervisors, and administrators. This committee would have the responsibility for the decision making and actual work associated with the recommendations presented for most of the component features of the model. The main recommendations and, in some instances, related suggestions or sub-recommendations for each of the component features of the model follows.

Science curriculum: Objectives (pp. 119-128); Content (pp. 128-137)

Recommendation 1. The curriculum development committee undertake as its first task the determination of the values that science instruction may have for elementary school children in Iran and upon the basis of such values formulate the objectives for science in the elementary schools of Iran. (p. 126)

Recommendation 2. The science curriculum committee should determine the science content which they consider all children should have as the basic knowledge for understanding the environment and for their growth toward effective citizenship. (p.133) The science content areas suggested are: living things, the environment, health, matter and energy, and the universe.

Recommendation 3. After the content areas have been chosen by the curriculum development committee, there be formed separate sub-committees according to the selected content subject areas. (pp. 135-6) The recommendations made with respect to the responsibilities for each of the sub-committee are:

1. The responsibility for producing the content and the learning experiences in a sequential development for grades one through five.
2. The responsibility for establishing the content which would be considered the minimum essentials for implementation in all the elementary schools

in Iran and also for the development of supplementary materials to serve the needs of specific elementary schools.

3. The responsibility for developing the evaluative exercises for the textual materials.

4. The responsibility for the materials to be included in the teacher manuals for each grade level relative to the concepts to be taught and the ways for implementing the learning exercises. Each sub-committee should also be responsible for the science content to be included in the manuals as well as answers for problems and questions. (p. 136)

Recommendation 4. The materials developed by the sub-committees be incorporated into a new science textbook series for the elementary schools of Iran. (p. 137)

Teaching procedures. (pp. 137-147)

Recommendation 1. Each sub-committee attempt, insofar as it is considered feasible, to follow an organizational format that will emphasize an inquiry or discovery approach for the learning activities that are included in the lessons for the units at each grade level. (p. 138) It is to be noted that the classroom climate should be child-centered with pupils engaging in activities that involve the direct observing and handling of objects and in experiences whereby they find out for themselves some facts and concepts through inductive and trial and error processes.

Recommendation 2. A special "teacher manual committee" be formed consisting of one individual from each of the area sub-committees and selected individuals for the preparation of the teacher manuals grades one through five. (p. 139)

The "teacher manual committee" should have the responsibility for writing the general comments, for explaining teaching procedures, and for correlating the subject matter concepts and factual material produced by the sub-committees for the manuals. These manuals should be designed and developed in detail as to content, teaching procedures, use of instructional materials, and pupil evaluation in order to be useful to teachers.

Instructional materials--other than textbooks and audio-visual aids. (pp. 147-150)

Recommendation 1. Each subject matter sub-committee in the preparation of the units for each grade should prepare a list of the instructional materials that would be needed for the implementation of the exercises, experiments, and activities contained in each lesson in the units produced. (p.148) It is suggested that the sub-committees give due cognizance to developing pupil activities that are designed to use equipment and/or supplies that are easily obtained, safe for children to use, and that do not require complicated equipment.

Recommendation 2. The equipment and supplies needed for the lessons in the units developed in each subject matter area at each grade level be purchased and assembled centrally as a complete teaching package similar to the way the Science Curriculum Improvement Study was done with the materials needed for the implementation of that program. (pp. 149-150) It is suggested that the responsibility for implementing this recommendation be assumed by the present organizational department in the Ministry of Education which is concerned with instructional materials.

Instructional materials--audiovisual aids. (pp. 150-155)

Recommendation 1. The functions and responsibilities of the present media department of the Ministry of Education should be enlarged to include active participation in the procedures followed in the development of a new science curriculum. (p. 153-154)

Recommendation 2. Additional administrative policies should be developed which would provide channels for improving the existing audiovisual centers at the offices of education in Ostans, Shahrestans, and districts and for establishing, upon the basis of valid criteria, new audiovisual centers where needed. (p. 154)

Recommendation 3. Administrative policies should be established for the handling of audiovisual aids in each school regardless of the size or geographical location of the schools. (p. 155)

Pupil evaluation. (pp. 155-161)

1. Recommendation 1. The science development sub-committees prepare as an integral part of the respective subject areas evaluation exercises for the lessons and units to be developed at each grade level. (p.156)
2. Recommendation 2. The teacher manuals include a treatment of the modern concepts and purposes of evaluation. (p. 157)
3. Recommendation 3. The Department of Planning and Research in the Ministry of Education be represented on the Science Curriculum Development Committee and that it assume the responsibility for the development and implementation of the evaluation techniques and procedures which have national application. (p. 160) These techniques and procedures would be:
    1. The preparation of the general information in the teacher manuals relative to modern concepts of evaluation in the elementary school.
    2. The development of standardized tests for appropriate grade levels.
    3. The establishment of procedures and policies for administration of the tests.

Teacher training. (pp. 161-167)

Recommendation 1. The Department of Teacher Training in the Ministry of Education be represented on the Science Curriculum Development Committee and that the department assume the responsibility for developing the policies and for implementing such policies relative to the training of elementary teachers to use the new science curriculum. (p.166) Inherent in this recommendation are the suggestions that the department

1. develop appropriate instructional materials for conducting workshops and in-service programs for implementing the new science curriculum.
2. provide the personnel for conducting workshops for selected individuals from the present elementary teacher training institutes.
3. provide the personnel for conducting in-service training for the teachers in the schools which may be selected as "trial schools" in the proposed method for evaluation of the model.

Recommendation 2. The workshops for the individuals selected from the present elementary teacher training institutes be limited to not more than twenty-five members and that such workshops be at least two weeks in length. (p. 167)

Recommendation 3. Plans be developed and implemented whereby the individuals presently employed in teaching in the elementary schools throughout the country receive training through in-service programs or workshops in the use of the new science curriculum. (p. 167)

Model evaluation. (pp. 169-170)

Recommendation 1. The Ministry of Education select "trial schools" for trying out the new science curriculum. (p. 169)

Recommendation 2. The teachers in the "trial schools" be given in-service training with the new curriculum materials prior to the use of the materials in the schools. (p. 169)

Recommendation 3. The Ministry of Education assign an evaluation team to prepare evaluation forms for teacher evaluation of the effectiveness of the new materials and that this team conduct personal on the site evaluations in the "trial schools." (p. 169)

Recommendation 4. The evaluation team analyze the teacher evaluations and together with their own conclusions prepare a feedback report to the members of the writing sessions prior to the sessions where the final editions are to be produced. (p. 170)

In addition to the specific recommendations for each component of the model, the following recommendations were made relative to the work of the sub-committees. (pp. 167-169)

Recommendation 1. Writing sessions for the work of the subcommittees be established for periods of four to six weeks in which the members would devote full time to the development of the lessons and units and other associated tasks. (p. 168)

Recommendation 2. The first writing session be devoted to the production of the textual and associated materials for grades one through three. (p.168) Implicit in this recommendation is that these materials would be forwarded to the proper administrative department in the Ministry of Education for publication.

Recommendation 3. A second writing session be devoted to the production of the textual and associated materials for grades four and five. (p. 168)

Recommendation 4. After the materials have been tried out in "trial schools" writing sessions be held for re-evaluation and re-writing prior to the publication of the final editions of all the materials. (pp. 168-169)

Recommendation 5. All the writing sessions should include, in addition to the members of the sub-committees, representatives of the various departments in the Ministry of Education which have assumed the responsibility for developing and/or implementing other facets of the curriculum as recommended in this study. (p. 169)

Implications for further study. The following suggestions are made as to problems which could be investigated in efforts to improve the first cycle of general education in Iran with particular attention to science instruction.

1. The effect of increasing the time allocated to science instruction on pupil achievement in science and in the acquisition of defined behavioral objectives.
2. The effect that availability of instructional materials including audiovisual aids has on pupil achievement of the objectives of the new science curriculum.
3. The value of workshops and/or in-service programs for implementing the new science curriculum.
4. The development and evaluation of new approaches for training pre-service teachers in the elementary training institutes for implementing the new science curriculum.
5. The development and implementation of models for other subject matter areas in the present first cycle of general education.

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