A MODEL FOR THE DEVELOPMENT OF SCIENCE CURRICULA IN THE PREPARATORY AND SECONDARY SCHOOLS OF THE UNITED ARAB REPUBLIC

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Troy L. Stearns
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ABSTRACT

A MODEL FOR THE DEVELOPMENT OF SCIENCE CURRICULA
IN THE PREPARATORY AND SECONDARY SCHOOLS
OF THE UNITED ARAB REPUBLIC

by Gamal A. Elashhab

The purpose of this study was to build a model for the development of science curricula in the preparatory and secondary schools of the U.A.R. The study has focused on developing a rationale for decision making in curriculum improvement. This rationale has been developed through the examination of three major areas: (1) the culture and social problems, (2) the learning process and the learners, and (3) the nature and structure of science--the examined discipline. The implications of such examinations to science curriculum development were expressed in two categories: (1) desirable learning experiences, and (2) desirable behavioral outcomes.

A set of criteria was developed from literature to guide the following processes: (1) stating objectives, (2) selection of content and learning experiences, (3) organization of learning experiences, and (4) establishing a comprehensive program of evaluation.

A set of objectives for teaching science was stated in behavioral terms. These objectives illustrate the

workability of the proposed criteria in the selection of objectives. The applicability of the rest of the criteria was demonstrated in screening the current curricula to identify some weaknesses.

A model for the development of science curricula in the preparatory and secondary schools was proposed. A period of three years was proposed as necessary for processes of planning and trial of the new curricula before they are generalized in U.A.R. schools.

The study was ended by some recommendations for further studies.

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By

Gamal A. Elashhab

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CHAPTER I

INTRODUCTION

The Purpose of the Study

The purpose of the study is to construct a model for the development of science curriculum in the preparatory and secondary schools in the United Arab Republic. The model should serve as a theoretical structure for initiating studies on science curricula in the Republic.

The Need for the Study

Most of the attempts to improve the science curriculum in the preparatory and secondary schools have resulted in minor development. Some important objectives of teaching science for behavioral changes remained unaccomplished due to one or more of the following factors.

1. National curriculum development committees have viewed science curriculum mainly in terms of subject matter content. This led to curriculum change by merely adding or eliminating certain areas within subject matter content. The following quotation from a paper presented by Eisa at the Fourth Convention of Arab Teachers represents this point of view.

> Curriculum committees have studied some remarks about the current curriculum and the recommendations of the twenty third International Convention on Education in Geneva, and compared our curriculum with curricula abroad. They have suggested a plan to develop the current curriculum in such a way that:
>
> (1) To transfer the curriculum of the tenth grade to the preparatory school (7-9th grade) and limit the study of biology in the tenth grade to the study of the human body.
>
> (2) To reorganize the physics curriculum in the eleventh and twelfth grades and distribute the content on the tenth, eleventh and twelfth grades after the adding of elasticity, surface tension. . . .
>
> (3) To reorganize the chemistry curriculum in the last two years of the secondary schools and then distribute the content in three grades with addition of plastics, radioactivity. . . .
>
> (4) To eliminate some of the topics in biology which are not related to the pupil's life.
>
> This means that a radical change is introduced. . . .[1]

This quotation illustrates a prevalent view of the nature of curriculum and curriculum development. In order for the curriculum to bring about behavioral change in the learners, it should be viewed in terms of learning experiences rather than subject matter content.

2. With the content oriented view, social, philosophical, and psychological foundations have not been seriously considered. When they have been mentioned

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[1]Ahmed Eisa, _et al._, "Development of Science Teaching in Secondary Schools of U.A.R.," A paper presented in the Fourth Convention of the Arab Teachers in Alexandria, U.A.R., August, 1965, p. 5. (Mimeographed.)

in the objectives, they are expressed in broad and imprecise terms which do not help the teacher in selecting learning experiences. This need for clearer objectives was expressed by the faculty of the College of Education in Ein Shams University in their paper presented in the same conference.

> . . . it is about time to have leaders of science education confer to decide what the main objectives of science education should be without complete reliance upon the transference from countries which differ in their past, present and future aspirations.[1]

The need for phrasing the objectives in more operational terms which emphasize the behavioral patterns sought was expressed in the eighth recommendation of the convention.

> To phrase the objectives of teaching science in a way which facilitates its translation into attainable behavioral patterns. . . .[2]

The previous quotations suggest an urgent need to phrase the objectives of science teaching in behavioral terms.

3. The previous attempts failed to develop a rationale for decisions made in curriculum improvement. The

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[1]Salah Kotb, et al., "Objectives of Teaching Science," A paper presented to the Fourth Convention of the Arab Teachers in Alexandria, U.A.R., August, 1965, p. 4. (Mimeographed.)

[2]Recommendation of the Fourth Convention of the Arab Teachers, "Development of Science Teaching in the Arab World," A paper presented to the Fourth Convention of the Arab Teachers, Alexandria, U.A.R., August, 1965, p. 4. (Mimeographed.)

selection of objectives, planning and organization of learning experiences, and planning for evaluation should be based on a definite framework. This framework could be constructed from: (a) examining the culture and the social problems and values, (b) reviewing research on human learning and studies about the learners, (c) examining the nature and structure of the discipline (science).

4. Teachers have always been overlooked as important participants in curriculum development committees. The classroom teacher could contribute effectively in such a committee and should be included in the planning of change.

Design of the Study

This study is meant to be a synthetic study. This term is defined here in the same way it is defined in *Research in the Teaching of Science*.

> Synthetic studies are investigations in which various curricular materials, resource-use data, instructional suggestions, references, and aids to teaching are brought together into a unified pattern to be helpful in an educational situation.[1]

The study aims at building a model for the development of science curriculum in the preparatory and secondary

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[1] *Research in the Teaching of Science*. Analysis and Selected Abstracts: 1959-1961. Studies completed 1959-1963 (Washington: U.S. Government Printing Office, 1965), p. 3.

schools of the U.A.R. The following operational objectives are sought:

1. To examine social problems, values, and beliefs and relate them to science curriculum development.
2. To relate research findings on human learning and on the nature of the learners to science curriculum.
3. To examine the nature and structure of science and to review literature on science teaching. The results of such examination could help in developing a rationale for curriculum development decisions.
4. To develop from the previous three steps a rationale which will be used as a base for a proposed model. This model will include:
   a. Stating objectives
      1) Criteria for the selection of objectives
      2) A suggested list of objectives of teaching science in the preparatory and secondary schools
   b. Selecting learning experiences
      1) Definition of learning experiences
      2) What criteria should be used to select learning experiences?
   c. Organizing learning experiences
      1) Definition of the term "organizing"

2) What are the characteristics of an effective organization?

d. Evaluation

1) What is meant by evaluation?

2) Characteristics of a comprehensive evaluation program

e. Summary of processes suggested for curriculum development.

5. To screen the current curriculum in view of the rationale developed for the model to define the weaknesses.

6. To recommend to the Ministry of Education an approach for improving science curriculum in the United Arab Republic.

Definition of Terms

Model:

The most general sense of the term model seems to be that of an "ideal type" of structure or process, arrived at by hypothetical reasoning from theoretical premises, which is then used, through comparison with empirical data to analyze such data. In this meaning model seems to be almost identical with theoretical scheme.[1]

Curriculum:

Curriculum is defined in terms of the quality of pupil experiences. It is conceived of as the whole of the

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

interacting forces of the total environment provided for pupils by the school and the pupils' experiences in that environment.[1]

Learning experiences:

The term "learning experience" is not the same as the content with which a course deals nor the activities performed by the teacher. The term "learning experience" refers to the interaction between the learner and the external conditions in the environment to which he can react.[2]

Basic Assumptions

1. "Curriculum study needs theoretical constructs from which hypotheses can be derived and empirically tested with a view in determining, for example, how curriculum content has been established."[3]
2. A rationale for decisions in curriculum development is urgently needed. It should draw upon information about society, the learners, the process of learning, and the nature and structure of science.
3. An extensive review of literature in curriculum planning and research in science education in a more advanced country like the United States of

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[1] Vernon E. Anderson, Principles and Procedures of Curriculum Improvement (New York: The Ronald Press Company, 1956), p. 9.

[2] Ralph W. Tyler, Basic Principles of Curriculum and Instruction (Illinois: The University of Chicago Press, 1963), p. 41.

[3] John I. Goodlad, "Curriculum Planning and Development," Review of Educational Research, XXX, No. 3 (June, 1960), 194.

America might be helpful if translated to evoke curriculum studies and research in the U.A.R.

4. The author hopes through his position as one of the science curriculum coordinators of the Ministry of Education in the U.A.R. that the workability of the model could be tested which might initiate further studies in science curriculum planning.

Delimitations of the Study

1. Due to the limitations of time, the study will be confined to the six operational objectives stated previously. No empirical testing of the workability of the model would be conducted in this study.
2. The study is not directed toward the selection of subject matter content or its placement in a certain grade. Where this is to be done, it is only to give an example to illustrate a general principle or a recommendation.
3. Detailed learning experiences are not sought either. They are to be determined by the committees suggested in the model.

CHAPTER II

THE UNITED ARAB REPUBLIC AND ITS EDUCATIONAL SYSTEM

Historical Synopsis

Egypt is one of the oldest countries in the world. On the banks of the Nile, one of the basic cornerstones of the human civilization was established. Ancient Egyptians had great respect for and much reliance upon education. This great love for education was inherited by the following generations. It has been with Egyptians since then.

Unfortunately, the country has been exposed to several occupations by different foreign troops. The foreign control of the country has often impeded the desire of people to educate their children in the way they wanted. Egypt was exposed to different cultures during the Turkish, French, and finally the British occupations. The most well-known effect of these occupations was a continual denial of the citizens' right to follow their grandparents' line of getting a good education. As Lengyel states:

> Thus, the Middle East was part of cultural revolution, and this was for several reasons. The bulk of the area had formed the core territory of the Ottoman Empire for centuries. While it had been an effective military machine in its heyday, the empire was always

distrustful of secular knowledge and anti-intellectual. It scanned any influence that might detract from the belligerent qualities of its fighting men with suspicion.
The coreland of the Middle East fell into Western hands in the wake of the first World War. It was some of the main exponents of western culture, the French and the British, who ruled over those regions as mandatory powers under the auspices of the League of Nations and "protectors." Barring the usual exceptions, they deemed it unwise to provide the entire population, mainly Arabs and ethnic minorities with education. Schools were eye-openers, purveyors of skills that might have rendered the western powers superfluous.[1]

Harby expressed the common doubts about the British seriousness and sincerity in spreading education:

> . . . after fourteen years from the time it pretended assuming responsibility for spreading elementary education among the people, no more than ninety three Kuttabs (elementary school) existed in the country which represented an increase of only two kuttabs per year. . . . Furthermore, kuttabs were badly distributed and no attempt was made by the British administration to amend this distribution. The total in Cairo was seventy-five kuttabs compared with eight in Lower Egypt and ten in Upper Egypt.[2]

Only three secondary schools existed in 1893 after eleven years of occupation.[3] The insight given to the educational system by Egyptian scholars who had studied abroad, especially by some nationalistic movement leaders like Mustafa Kamel, led in 1908 to the establishment of

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[1]Emil Lengyel, "Educational Revolution in the Middle East," Teachers College Record, LXIV (November, 1962), 99-100.

[2]Mohammed K. Harby and Elsayed M. Elazzawi, Education in Egypt (U.A.R.) in the 20th Century (Cairo: Government Printing Offices, 1960), p. 10.

[3]Ibid., p. 12.

the private Egyptian University along the lines of European universities. After Egypt had its first constitution in 1923, many attempts have been made to provide universal free primary education. Most of those attempts have failed due to the lack of seriousness and the British control over the government and the kingdom.

In 1952, the Egyptian revolution ousted the king and started a new era of Egyptian history. The revolution gained complete independence for Egypt in 1956. Special care was given to education. This can be illustrated by the graph showing the growth of the budget of the Ministry of Education and the four universities.[1]

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[1]United Arab Republic, Documentation Centre for Education, Education in the United Arab Republic, 1962, p. 2.

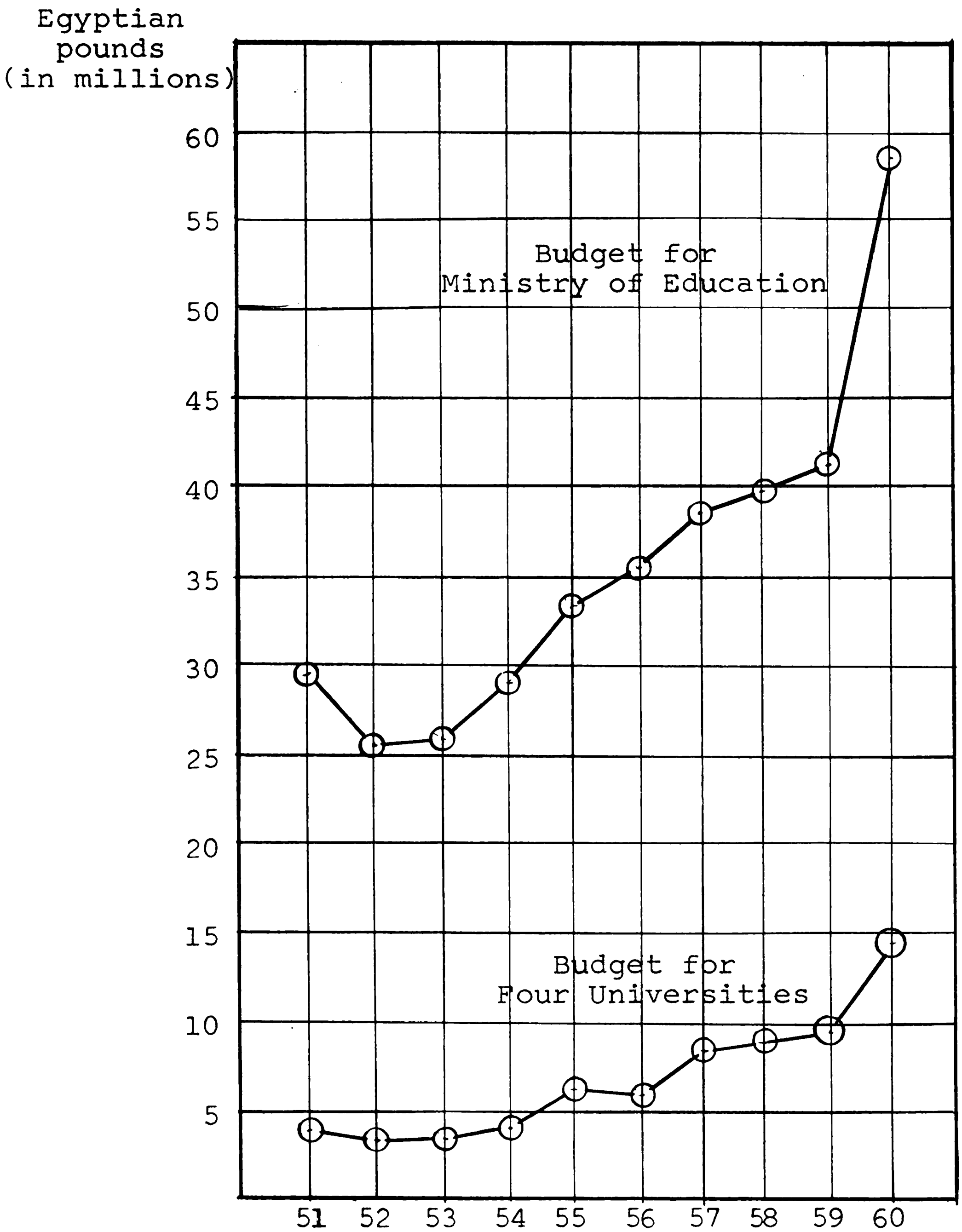

Fig. 1.--The Growth of Budget for Ministry of Education and the Four Universities

The Current Scene of the Educational System in the United Arab Republic

I. Administration

Education in the United Arab Republic is a state function. It is financed through the national budget. The government provides free education in all the stages from grade one through the university to all those who prove competent and show personal motivation. Universal free compulsory education is provided from age six to age twelve.

Because the Ministry of Education plans the educational policy at Cairo, the system is, so far, more centralized than decentralized. National curricula is planned by the Ministry of Education, which provides schools with teachers, supervisors, textbooks, teacher guides, and audio-visual materials.

The first five-year plan has rendered the establishment of a local government system which is very similar to that of the United States of America. The country is divided into governorates, each of which has its own governor and local government. Now there are twenty-four educational zones. Each educational zone has its own director appointed by the Ministry of Education. The zone has different departments for elementary, preparatory, secondary, and technical instruction. Each department has its own superintendent.

Local educational zones are charged now with some responsibilities which formerly belonged to the Ministry of Education, such as the appointment of elementary school teachers and their promotion, selection of textbooks from the Ministry's alternatives, modifying the curricula, and establishing new classes and schools.

The trend toward more local control is encouraged and enhanced by the government; nonetheless, it is often impeded by traditions and resistance to change.

II. The structure of education in the United Arab Republic

Figure 2[1] represents a general picture of the structure of education in the U.A.R.

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[1] *Ibid.*, p. 4.

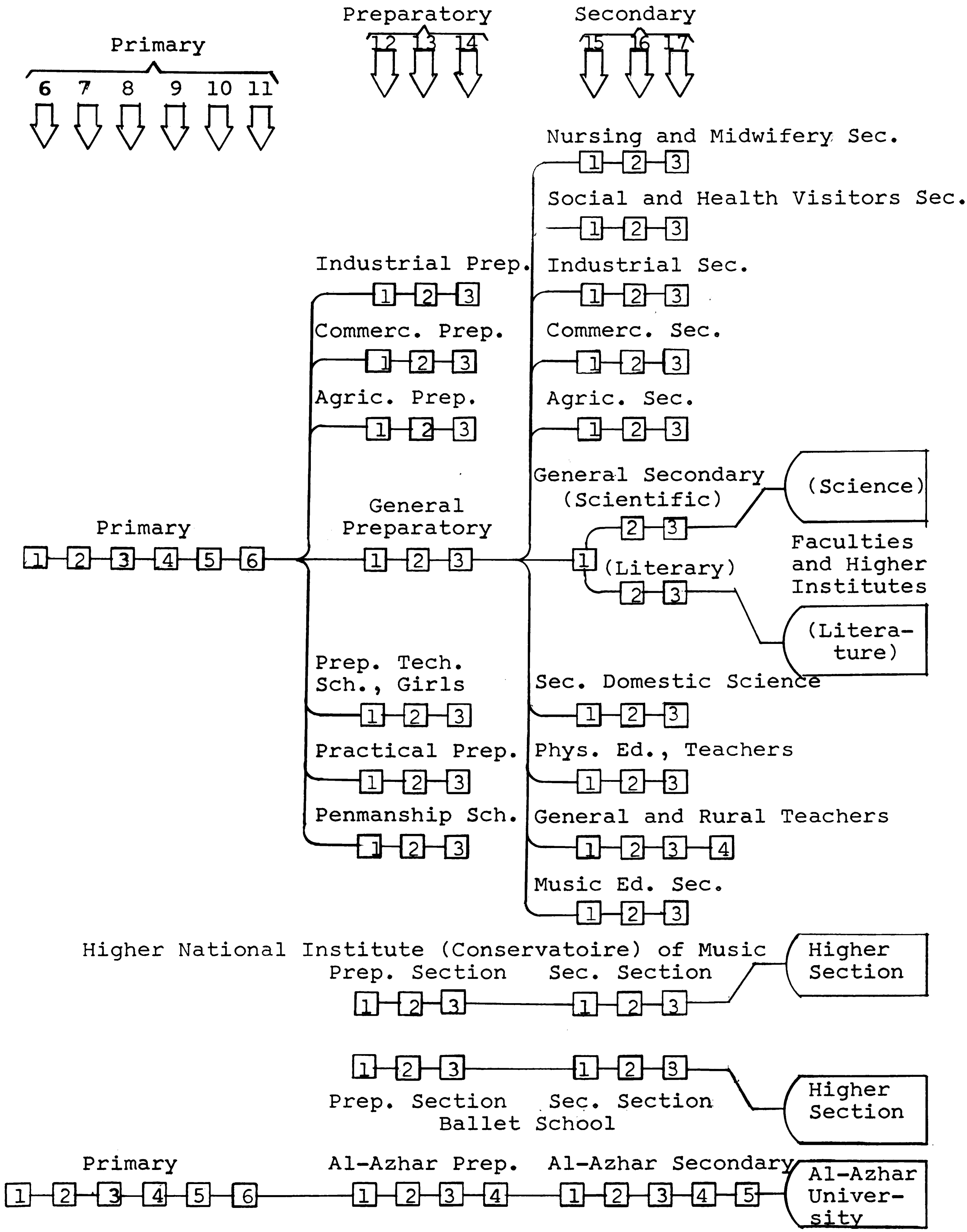

Fig. 2.--The Education Ladder in the U.A.R.
(Education Documentation Center of U.A.R., April, 1962)

A. The general education

General education is composed of three general stages:

1. The primary school (six years)

The primary school starts from age six and ends with age twelve. About ninety per cent of the children who are six years of age attend schools. Compulsory primary education will be fulfilled at the end of the second five-year plan (1969-1970).[1] The emphasis in the primary school is getting children acquainted with their environment. Reading, writing, arithmetic, national history, civics, general science, and physical education are taught. Promotion of students from one grade to the other is secured if the child satisfies the attendance rules. Children may be retained if the teacher claims it necessary.

2. The general preparatory school (three years)

This school is an equivalent of the junior high schools in the United States of America. Children who finish primary schools and would like to enroll in the preparatory schools must

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[1]Hassan Moustapha, "Some Problems of Planning General and Technical Education in the United Arab Republic," A paper presented in a seminar of the Institute of National Planning, No. 298, May, 1963, p. 2. (Mimeographed.)

prove scholastically capable by passing the entrance examination prepared by the educational zone to which they belong. Subject matter content is parallel to that found in the primary schools with some emphasis on content which prepares the student for secondary school. A general examination prepared by the educational zone should be passed by the pupil at the end of the last year of the preparatory school (ninth grade), so he can be awarded the preparatory school diploma.

3. Secondary schools

Students who get the best grades in the final examination of the preparatory school are admitted to secondary schools. The first offers comprehensive experiences in which all students are taught the same subject matter. Arabic language, national history, civics, religion, English, chemistry, physics, mathematics, physical education, and art are taught. In the second year the student has the choice of pursuing one of two branches: (a) science branch--emphasis is placed upon physics, mathematics, chemistry, and biology, or (b) humanities branch--sociology, philosophy, linguistics, or national history is in focus. Students must

pass a national examination at the end of twelfth grade to be awarded the secondary school diploma.

4. Higher education

The students who graduate from the science branch in the high schools join either of the science oriented colleges, such as the colleges of medicine, pharmacy, engineering, pure science, agriculture, veterinary medicine, or dentistry. Those who graduate from the humanities branch join colleges of humanities, law, or colleges of business. In most of these colleges students study for four or five years before getting the bachelor's degree. Graduate studies are established and are becoming widely supported in the four universities.

B. Technical education

The Egyptians were faced after the revolution by the fact that they were too far behind the world economically and educationally. The need for industry was deemed urgent by both specialists in national economic planning and foreign experts. Between 1952 and 1964 about eight hundred factories were established. Many technical schools were built to provide those factories with skilled labor. The person who examines the ladder

(Figure 2) might be surprised by the seeing of so much early specialization within the schools. However, one must view the educational system in underdeveloped countries in the frame of the social progress. Some of the technical schools are:

1. Industrial preparatory and secondary schools
2. Business preparatory and secondary schools
3. Agricultural preparatory and secondary schools
4. Comprehensive technical preparatory and secondary schools.

Students who receive the diploma of the secondary schools with a satisfactory record are allowed to enroll in higher corresponding institutes, such as the Agriculture High Institute, Industry High Institute, and the like. These institutes emphasize the technical approaches rather than the theoretical.

C. Alazhar

The old Islamic university of Alazar was established more than a thousand years ago. Formerly the curriculum centered upon Islamic studies and Arabic language. In 1961 an act was passed to modernize this large institute and bring it in line with regular general education. As the figure on page 15 indicates, Alazhar has one more grade added to its preparatory school which makes it four years

instead of three. Two more years were added to the secondary schools which makes it five years instead of three. The additions were justified by the fact that students cover the Islamic courses which are not required in the corresponding general public schools.

CHAPTER III

A REVIEW OF LITERATURE

Social Problems and the Curriculum

Curriculum experts have always emphasized the need of taking social problems and goals into consideration when planning curricula. This principle has some direct implications to curriculum development.

> . . . (1) It demands increased attention to the civic and political needs of the nations: to developing new attitudes toward government and law, to concern with effective participation in the political process, to placing national interests and well-being above narrow tribal or local interests. (2) It demands increased attention to the social and personal needs of the nation: to improving the health and well-being of the people, to solving problems of mental and physical health as they arise, to maintaining the individual's self-respect and self-confidence in new surroundings, to relating the new cities with the rural communities in a spirit of partnership, to increasing rather than breaking down the respect of different age groups for one another. (3) It demands increased attention to the economic and technological needs of the nation: to selecting and educating qualified individuals for high level positions, to equipping technical and agricultural manpower with skills that will produce maximum efficiency in using natural resources, to developing a new spirit of economic innovation and to building new attitudes toward saving, investment and purchasing.[1]

As was mentioned in the first chapter, a conscious effort is lacking on the part of curriculum planners to

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[1]John W. Hanson and Cole S. Brembeck, Education and the Development of Nations (New York: Holt, Rinehart and Winston, Inc., 1966), pp. 33-34.

identify the social aims and to use them as one of the foundations of the curriculum. The first part of this chapter will consider some of the social problems and their implications to curriculum development in the U.A.R.

The Standard of Living

The United Arab Republic is a poor country. According to the economists it falls in the category of underdeveloped countries. A simple yardstick for measuring a country's relative development is the average annual per capita income of its citizens. This index is arrived at by taking its total annual income, as revealed through production figures and other data, and dividing it by the number of individuals of all ages and conditions.[1] Using the concept of the income per capita to categorize the countries of the world, one finds that the U.S.A. and Canada and several of the European countries are at the top of the list with average annual per capita incomes between $1,000 and $2,000.[2] Hoffmann suggested a border line which would distinguish developed countries from underdeveloped countries:

> We can safely take a $300 average annual per capita income as the dividing line between the developed and the underdeveloped countries.[3]

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[1] Paul Hoffmann, "What Is Underdeveloped World?" Education and the Development of Nations, eds., John W. Hanson and Cole S. Brembeck (New York: Holt, Rinehart and Winston, 1966), pp. 33-34.

[2] Ibid., p. 46.

[3] Ibid.

The U.A.R. has a low level per capita income of $150.[1] The Egyptian natural resources are limited almost to the Nile water and six million acres of cultivatable land. After 1952 the new government was faced by limited natural resources, no forests, vast deserts, few natural sources of power, and negligible discovered raw mineral materials. Bringing about economic growth is one of the main objectives of the country. The government adopted an extensive program of industrialization and agricultural growth. The Aswan High Dam will enable the country to add thirty per cent to its cultivatable land and will provide an amount of electrical power which will cover the whole country. Two five-year plans have been started: (1) 1960-1965 first five-year plan, and (2) 1965-1970 second five-year plan.

The main objectives of the plan as expressed by the Institute of National Planning (IONP) are:

a. The expansion of output and production and the increase in per capita income at a rate that would lead to doubling the national income by the end of a period of ten years (1960-1970).
b. Creating an industrial base that would provide for the sustained growth of production to be achieved in the future at ever increasing rates.[2]

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[1]Salah Elserafy, "Economic Development by Revolution--The Case of the U.A.R.," Middle East Journal, XVII, No. 3 (1963), 216-17.

[2]I. H. Abdel Rahman and N. Deif, "The Social Aspects of Development Planning in the U.A.R.," Memo No. 76 of the I.O.N.P. (November, 1961), p. 1.

A summary of social "obstacles" to economic development will help in finding out how a curriculum could serve national economic growth. Mr. Hamza,[1] the Director of the Institute of National Planning, reviewed these obstacles in a local seminar and placed them in three categories.

1. Population factors

   a. Since economic growth is ordinarily defined as growth in per capita national income, which in turn is defined as the ratio of production to population, it is obvious that trends in population can, mathematically speaking, play as large a role in economic growth as trends in production. (This will be discussed in detail when population growth is reviewed.)

   b. Population structure is the relative proportion of economically active adults versus children and inactive elderly persons.

2. Institutional factors

   a. Among the institutional forms more generally cited as obstacles to economic development are caste and class systems that freeze individuals in ancestral occupations and reward them on the basis of birth rather than ability or achievement.

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[1]M. Hamza, "The Interrelation of Social and Economic Development and the Problem of 'Balance,'" Memo No. 331 by the I.O.N.P. (May, 1963), pp. 5-21.

b. One common factor between developed countries is the important role of their educational system. Much of the education is deliberately and strongly oriented towards technological change and economic progress, unlike, for example, the educational systems of medieval European scholasticism or traditional scholasticism.

c. The large extended family impedes the development of new methods of work and production.

3. Individual factors

a. The lack of an entrepreneurial attitude on the part of those individuals who do command a certain amount of resources. They prefer to have their money in land, causing undue inflation of land value, or in foreign investment. Poorer classes may hoard gold coins or store up food.

b. "Achievement motivation" is assumed to highly affect economic growth. Women in the U.A.R. are characterized by a low level of this motive.

c. Much higher status tends to be associated with land ownership, government position, and intellectual activity than is enjoyed by the businessman, engineer, mechanic, agronomist, or other persons concerned directly with national production.

d. Poor physical capacity due to endemic diseases or malnutrition affect production.

The aforementioned regarding the standard of living and obstacles to economic growth have the following implications to curriculum development, especially in science:

1. Desirable learning experiences
   a. Learning about natural resources and how to increase them.
   b. Conservation energy and energy transformation.
   c. Ways science can serve economic growth.
2. Behavioral goals and desirable values and attitudes
   a. Accepting change as a universal phenomenon and readiness to cope with it when it occurs.
   b. "The schools of the nation must foster a spirit of innovation in their students--a desire to try out, to experiment, to create."[1]
   c. Developing a new attitude of adventuring. "The clerical mentality which finds it most acceptable to seek the security of government office must give way among an increasing number to a willingness to take a chance, to strike out on one's own."[2]
   d. Developing the habit of thriftiness and saving.

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[1]Hanson and Brembeck, *op. cit.*, p. 36.

[2]*Ibid.*

e. Believing in the free play of intelligence. Functional competence, not caste, class, or family, must become accepted as the only criteria of functional worth.

Population Explosion

The one particular economic variable which seems to grow in Egypt without much effort is population.

> A crude birth rate of about forty-five per thousand and death rate of about twenty per thousand, manages to give Egypt an annual rate of population increase of 2.5% which adds up to about 28% in a decade.[1]

It is predicted that in twenty years the population will be multiplied:

> According to the census taken in 1960, the population in the U.A.R. was 26,059,000 persons. With a population growth of 2.5% annually and decrease in death rates due to modern medical care, it is estimated that in another twenty years the population could easily reach 54,000,000.[2]

Such a high rate of population growth seriously affects the economic growth in many ways:

1. The fast growth of the population impedes the previously discussed plan to raise the per capita income.
2. The fast growth of the population also decreases "productivity" of the nation. As the I.O.N.P. states:

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[1]Elserafy, op. cit., p. 228.

[2]United Arab Republic, Information Department, Cairo, Handbook of U.A.R. Economy, 1963, p. 16.

> . . . the population structure has an obviously important bearing on economic development since the relative proportions of economically active adults versus children and inactive elderly persons will determine the amount of production beyond the worker's own needs that can be used for savings and investment, and the amount that must be consumed by non-productive dependents in food, education and health services, as well as housing and community facilities.[1]

If one studies the population structure of the U.A.R., he will be surprised by the figures.

> The proportion of children under the age fifteen is 40% of the population compared to 20% in west European countries.[2]

Two countries with initially equal labor productivity (production per worker) will have different rates of economic growth if, other things being equal, their population structures differ. This means that Egypt's chances of economic growth are very slim if the population structure stays as it is now.

3. The fast growth of the population upsets the five-year plan of public services. A fast growing population is made up increasingly of young people whose demand for education, health services, and housing keeps increasing at an accelerated rate. The ten-year plan estimated the population growth as 2.5 per cent annually. Apparently this rate was

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[1]Hamza, op. cit., p. 8.

[2]Information Department, op. cit., p. 17.

an underestimation of the actual population growth. This delayed, for example, the achievement of compulsory universal elementary education. Prime Minister Mohey Eldin expressed this in a recent speech delivered to a national teachers' conference:

> We will not be able to have all six-aged children into primary schools by 1970 as it was planned in the second five-year plan. It was predicted that the number of the six-aged children during the second five-year plan would be about four million. The recent statistics have shown that the number will be rather 5,014,000 due to an increase in the population growth rate.[1]

The aforesaid concerning the population growth also has implications to curriculum development especially in science.

1. Desirable learning experiences
   a. Units about reproduction in plants, animals, and human beings which would provide a base for sex education.
   b. A unit about birth control devices and social reactions to them.
2. Behavioral goals and desirable values and attitudes
   a. Fostering the "need for achievement" or what is sometimes called "achievement motivation." This is assumed to have new generations aspire for a better life which would delay early marriage.

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[1]Z. Mohey Eldin, "Teachers Should Take the Responsibility for Informing the Public!" The Arab Students, Issue 178 (February, 1966), p. 6.

Research is needed about ways of fostering such attitudes.

b. Students should be encouraged to carry on community studies such as the relation of income to the size of the family.

Employment, Underemployment, and Unemployment

The Institute of National Planning (IONP) has conducted two major studies about employment and underemployment among the educated citizens between 1961 and 1963. The first one conducted in 1960-1961 confined itself to secondary school graduates while the second study conducted between 1961-1963 focused on university graduates. Table 1, adopted from the (IONP) Memo No. 301,[1] gives the percentage of:

1. The graduates whose jobs suit their qualifications
2. The graduates whose jobs do not correspond to their qualifications
3. The unemployed graduates
4. Females who preferred to be housewives only.

From this table one discovers the following: (1) A relatively high percentage of graduates of theoretical colleges suffer from underemployment. In other words, they work in jobs which could be adequately performed by

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[1] M. Hamza, "The Analysis of the Employment Situation Amongst the Educated Classes in the U.A.R.," Memo No. 301 of the Institute of National Planning, 1963, p. 3.

TABLE 1

UNDEREMPLOYMENT AND UNEMPLOYMENT BETWEEN EDUCATED PERSONNEL IN THE U.A.R. 1961-1963

Qualifications	% of (a)	% of (b)	% of (c)	% of (d)	not shown
B. A. (Arts)	74.5	12.2	4.6	7.7	1.0
B. A. (Law)	84.8	9.8	2.7	1.6	1.1
B. Commerce	90.2	4.9	4.2	0.7	. .
B. Sc. (Science)	87.0	1.4	8.7	1.4	. .
Medicine and Pharmacology	95.2	1.0	1.9	1.0	1.0
Engineering	99.4	0.6	. .	. .	. .
Agriculture	93.2	2.6	3.4	0.9	. .
Fine Arts	94.4	10.0	. .	. .	. .
Social Work	89.1	17.5	. .	. .	. .
Sec. Indust.	80.7	13.6	5.7	. .	. .
Sec. Commerical	88.0	1.5	4.9	5.6	. .
Sec. Ag.	85.2	9.2	5.6	. .	. .
Sec. Feminine	26.7	5.4	2.2	65.6	. .

(a) The graduates whose jobs suit their qualifications.

(b) The graduates whose jobs do not correspond to their qualifications.

(c) The unemployed graduates.

(d) Females who preferred to be housewives only.

less educated personnel. This applies in particular to graduates of the faculties of Arts, Law, and Commerce. (2) There is a remarkably high percentage of unemployment among the graduates of the faculties of liberal arts (Arts and Science).

The huge number of university graduates especially in non-technical colleges is not proportionate with the economic progress. Harbison expressed this view:

> By most criteria Egypt is an underdeveloped country limited in resources, mainly a nation of farmers (65%), low in gross national product per capita ($140) and only semiliterate in terms of the proportion of its children who go to elementary school. But taking secondary and higher education into account, Egypt is a semiadvanced country.
>
> In proportion to its population Egypt has more students in universities than Britain and twice as many in secondary and higher education as West Germany.[1]

In view of the ten-year plan (1960-1970), more technical personnel are needed than graduates of theoretical colleges. The figures provided by long-term planning research conducted by the IONP clarify the unemployment situation. Table 2 indicates the percentage deficit of targeted demand in different professions to expected supply.

It is clear that more technical personnel are needed. The disrespect for vocational education is a social barrier to economic growth. The aforesaid regarding unemployment problems has some implications to curriculum development especially in science. For example, an extensive guidance program should accompany the curriculum development starting in the preparatory school. It is surprising that information about available jobs or

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[1]Frederick Harbison, "Education for Development," Education and the Development of Nations, eds., John W. Hanson and Cole S. Brembeck (New York: Holt, Rinehart and Winston, 1966), pp. 155-56.

TABLE 2

PERCENTAGE DEFICIT OF TARGETED DEMAND TO EXPECTED SUPPLY
(ON THE BASIS OF EXISTING EDUCATION SYSTEM)

No.	Occupational Grade	Educational Level	Balance Item				
			1965	1970	1975	1980	1985
1.	Managers and high professionals	Universities and higher institutes	− 6.7	− 9.4	−26.0	−34.5	−40.8
2.	Middle technical personnel	Technical secondary schools, teachers' training institutes, and vocational training centres	−24.0	−30.5	−38.5	−35.5	−31.8
3.	Clerks of co-ordinating staff	General secondary schools	−12.4	−25.8	−35.5	−39.0	−42.5
4.	Skilled and unskilled labour	Primary and prep. schools	+ 2.4	+ 5.4	+ 9.8	+14.0	+18.5

training centers is rarely provided for preparatory school students in spite of the fact that 40 per cent of these students enter the labor market after graduating.

1. Desirable learning experiences

   a. The practical application of pure science which might require manual work should not be overlooked in the process of teaching the theoretical bases.

   b. Learning experiences which would be better provided in a factory, a workshop, or a training center, should be provided there. More appreciation of the skills associated with the blue-collar workers might be developed through such experiences.

2. Behavioral goals and desirable values and attitudes

   a. Instrumental skills should be considered more seriously. The continual concentration on retaining facts supports the popular view of supremacy of intellectual work.

Illiteracy

As recently as 1947, the illiteracy rate in Egypt was 80%. The government then spent about 3.5% of the budget on education, and the number of children in the state primary schools was 250,000 boys and 30,000 girls. Today the share of education in the national budget has increased to more than 15% and the number

of elementary school pupils has risen to 1,500,000 boys and 200,000 girls.[1]

In spite of the continuous effort to decrease the illiteracy rate, it remained over 60 per cent.[2]

Such a high percentage of illiterate citizens adds to the economic and social problems and works as a permanent barrier to needed progress and change.

Illiteracy might be responsible for, or at least contribute to, the existence of superstitious ways of thinking and some undesirable attitudes. Some examples of these are the following:

1. Fate

A high percentage of uneducated citizens accept illness, hunger, poverty, and plant diseases as fate. Brembeck believes it is a way of rationalizing:

> When misery is the common human lot it is easy to believe in fate. How else can one rationalize his existence and make it bearable? When death takes its high toll among village babies and children the bereaved parents can seal off some of the pain by believing that "God willed it," even though modern medicine could have saved the children if it were available. When the family's only buffalo cow dies, depriving it of milk, power, transportation, and body heat in winter, the loss is eased by "it was to be."[3]

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[1]Emil Lengyel, "Educational Revolution in the Middle East," Teachers College Record, LXIV (November, 1962), 102.

[2]Elserafy, op. cit., p. 216.

[3]Hanson and Brembeck, op. cit., p. 286.

2. Belief in evil spirits

A great number of villagers believe in the existence of evil spirits. Women, especially, believe that their illnesses are due to the occupation of their bodies by evil spirits. They attend ritual dances and under the loud noises of drums the sick woman dances vigorously to rid herself of the spirit. She might be asked to provide some gifts or to sacrifice some animals to satisfy the furious spirit. Even though a visit to a medical doctor might be urgently needed, the sick woman might keep on with this primitive kind of treatment. But they never forgot the old--almost sacred--proverb: "Ask him . . . who has suffered, and never ask a doctor." A related belief is that, "Illness is a punishment for being sinful."[1] This may lead some patients to indulge in ritual ways of treatment. This very belief often makes medicare efforts less effective.

3. Passivity-talk as a substitution for action

Egypt has been controlled by foreign powers for generations. Foreigners took the responsibility for decision making and actions. The ability to act rather than talk, as stated in Hanson and

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[1]Ayad K. Bibawey, Teaching Science in Preparatory Schools (Cairo: Maktabot Masr, 1957), p. 154.

Brembeck's book, "is atrophied through lack of use."[1] A great number of citizens rely on others or on the government to act or initiate action when it is necessary for them to take the initiative. Such passivity is witnessed in birth control campaigns, campaigns against illiteracy, and similar problems.

The discussion of the previous problem has some implications to curriculum development, especially in science.

1. Desirable learning experiences
   a. Micro-organisms' relation to diseases. Medicine in our lives.
   b. Learning experiences which help the students recognize the relationship between "cause and effect."
2. Behavioral goals and desirable values and attitudes
   a. To help the students to "move from intelligent talk to intelligent action. The gulf between talk and deed must be bridged."[2] Application of learning experiences to solve personal and social problems is very important.
   b. To initiate students to re-examine superstitious beliefs and arrive at scientific explanations

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[1]Hanson and Brembeck, op. cit., p. 285.

[2]Ibid.

to phenomena such as illness and plant diseases.

Psychological Foundations of Curriculum

What We Know about Human Learning

Due to the multiplicity of learning theories, one does not expect to find but few general principles which will be accepted by most of the learning theorists. It is difficult to find complete agreement. As Hilgard states:

> It would be too much to ask for perfect agreement, for some statements require many qualifications, and there are always a few theorists who are sticklers for wording.[1]

While reviewing literature on learning, the writer found three sources which tried to state some learning principles on which most learning theorists would agree. These three main contributions are the epilogue of Travers' book, Essentials of Learning,[2] Hilgard's book, Theories of Learning,[3] and an article by Watson published in a special feature of the NEA Journal titled Learning.[4]

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[1]Ernest R. Hilgard, Theories of Learning (New York: Appleton-Century-Crofts, Inc., 1956), p. 485.

[2]Robert M. Travers, Essentials of Learning (New York: The Macmillan Company, 1963), pp. 501-507.

[3]Hilgard, op. cit., pp. 485-87.

[4]Goodwin Watson, "What Do We Know about Learning," Special Feature of the NEA Journal: Learning (March, 1963), pp. 1-4.

In the following pages the writer will review research findings related to the following areas: reward and punishment, transfer of learning, motivation, and concept formation.

1. Reward (positive reinforcement) and punishment (negative reinforcement)

a. A reinforcer is a condition which follows a response and which results in an increase in the strength of that response. Good planning of reinforcing contingencies is one of the most effective ways of shaping behavior.[1]

Watson stated the same principle this way:

> Behaviors which are rewarded (reinforced) are more likely to recur.[2]

Watson agrees with Travers about the superiority of reinforcement as a single factor of shaping behavior:

> No other variable affects learning so powerfully. The best-planned learning provides for a steady, cumulative sequence of successful behaviors.[3]

b. Both Travers and Hilgard emphasize that reinforcement is most effective when it follows directly the right response:

> Reward (reinforcement), to be most effective in learning, must follow almost immediately after the desired behavior and be clearly connected with that behavior in the mind of the learner.[4]

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[1]Travers, op. cit., p. 502.

[2]Watson, op. cit., p. 1.

[3]Ibid. [4]Ibid.

> Reinforcements are most likely to be effective if they follow performance immediately. However, under suitable conditions they may be delayed and still be effective, provided the subject reinforced maintains an orientation toward the task.[1]

c. It is agreed upon that novel experiences may function as a good reinforcer. Travers expresses it as follows: "Any novel or unusual event may function as a reinforcer."[2] Watson clarifies:

> Experiments indicate that lower animals (rats, dogs, monkeys) will learn as effectively when they receive rewards of new experience or satisfied curiosity as they will when the rewards gratify physical desires. Similarly, stimulating new insights have been found to be effective as rewards for the learning efforts of human beings.[3]

The reader is referred to the studies by Olds,[4] Butler,[5] and Montgomery and Segall[6] as some confirming studies of the previous principle.

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[1]Travers, op. cit., p. 502. [2]Ibid.

[3]Watson, loc. cit.

[4]J. Olds, "Self-Stimulation of the Brain," Science, No. 127 (1958), pp. 315-24; and "Adaptive Functions of Paleocortical and Related Structures," Biological and Biochemical Bases of Behavior, eds., H. F. Harlow and C. W. Wodsey (Madison, Wis.: University of Wisconsin Press, 1958), pp. 237-62.

[5]R. A. Butler, "Discrimination Learning by Rhesus Monkeys to Visual-Exploration Motivation," Journal of Comparative and Physiological Psychology, XLVI (1953), 95-98.

[6]K. C. Montgomery and M. Segall, "Discrimination Learning Based on the Exploratory Drive," Journal of Comparative and Physiological Psychology, XLVIII (1955), 225-28.

d. The sense of satisfaction which results from achievement is the type of reward (reinforcement) which has the greatest transfer value to other life situations.[1]

e. The magnitude of the reinforcement provided is not necessarily related to the amount of learning produced.[2]

f. Experience without active participation and without reinforcement can conceivably produce learning, but the learning process involved is inefficient compared with that which occurs when performance is directly reinforced.[3]

g. Threat and punishment have variable and uncertain effects upon learning. They may make the punished response more likely or less likely to recur; they may set up avoidance tendencies which prevent further learning.[4]

The reader is referred to the studies by Mowrer,[5] Thorndike,[6] Estes,[7] Hull,[8] and Prince[9] for more details about punishment.

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[1]Watson, op. cit., p. 2.

[2]Travers, op. cit., p. 502. [3]Ibid., p. 503.

[4]Watson, op. cit., p. 1.

[5]O. H. Mowrer, Learning Theory and Behavior (New York: Wiley, 1960).

[6]E. L. Thorndike, Fundamentals of Learning (New York: Teachers College, Columbia University, 1932); and The Psychology of Wants, Interests and Attitudes (New York: Appleton-Century-Crofts, 1935).

[7]W. K. Estes, "An Experimental Study of Punishment," Psychological Monographs, No. 263 (1944), p. 57.

[8]Clark L. Hull, Principles of Behavior (New York: Appleton-Century-Crofts, 1943).

[9]A. S. Prince, "The Effect of Punishment on Visual Discrimination Learning," Journal of Experimental Psychology, XXXII (1956), 381-85.

h. Failure depresses those intellectual activities closely associated with school learning. Failure experiences are likely to result in relatively inefficient learning in the period that follows them.[1]

The previous principles about reward and punishment have the following implications to curriculum development and to teaching.

a. Reward, the most effective single factor in shaping behavior, should be provided for during the planning of learning experiences.

b. Evaluation must be a continuous process. Simultaneous reinforcement of responses is preferred to delayed reinforcement. The results of laboratory experiments should be evaluated in the same period if possible.

c. Knowing that novel situations may function as reinforcers, in teaching concepts, principles, or phenomena which were dealt with in previous grades, it is advisable to use new approaches, methods, and media.

d. A variety of learning experiences should be planned to provide a sense of success to every student. As Watson stated it:

> Pupils who have had little success and almost continuous failure at school tasks are in no condition to think, to learn, or even to pay attention. They may turn their

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[1]Travers, op. cit., p. 503.

anger outward against respectable society or inward against themselves.[1]

2. Transfer of Learning

a. Transfer of training is most likely to occur with well-practiced skills rather than with those in which a lesser level of skill has been acquired.[2]

b. Time devoted to the learning of principles may provide superior possibilities for the transfer of what has been learned to new situations, more so than the amount of time devoted to the learning of facts.[3]

c. Studies by Judd,[4] Hendrikson and Schroeder,[5] and Harlow[6] indicated that:

> Certain skills may be taught which have extensive applicability to the solution of new problems. The learning of these skills is referred to as the "acquisition of learning sets."[7]

The previous three principles have the following implications to curriculum development:

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[1]Watson, op. cit., p. 2.

[2]Travers, op. cit., p. 504. [3]Ibid.

[4]C. H. Judd, "The Relation of Special Training to Special Intelligence," Educational Review, XXXVI (1908), 28-42.

[5]G. Hendrickson and W. H. Schroeder, "Transfer of Training in Learning to Hit a Submerged Target," Journal of Educational Psychology, XXXII (1941), 205-13.

[6]H. F. Harlow, "The Formation of Learning Sets," Psychological Review, LVI (1949), 51-56; and "Learning Set and Error Factor Theory," Psychology: A Study of a Science, ed., S. Koch (New York: McGraw Hill, 1959), pp. 492-537.

[7]Travers, op. cit., p. 504.

a. In planning subject matter content, especially in science, emphasis should be upon general principles, concepts, and conceptual schemes rather than facts. As Bruner explained:

> . . . in order for a person to be able to recognize the applicability or inapplicability of an idea to a new situation and to broaden his learning thereby, he must have clearly in mind the general nature of the phenomenon with which he is dealing. The more fundamental or basic is the idea he has learned, almost by definition, the greater will be its breadth of applicability to new problems.[1]

b. Whenever mastering a certain skill is an objective, a thorough mastery[2] of the skill should be achieved by the students.

3. Motivation

a. "A motivated learner acquires what he learns more readily than one who is not motivated."[3]

b. "A person's level of aspiration is related to his history of experiences of success and failure."[4]

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[1]Jerome S. Bruner, <u>The Process of Education</u> (New York: Random House, Inc., 1960), p. 18.

[2]Travers, <u>op. cit.</u>, p. 216.

[3]Hilgard, <u>op. cit.</u>, p. 486.

[4]Travers, <u>op. cit.</u>, p. 505.

c. Studies by Berdie,[1] Gowan,[2] and Collins[3] proved that:

> Measured interests bear little relation to achievement. So far there is little evidence to show that interests, as they are commonly measured, reflect important motives.[4]

Thus, it is agreed upon that a motivated learner acquires what he learns easier than a non-motivated learner. What are the motives which teachers can utilize or arouse? Sears and Hilgard listed three categories:

a. Social motives: warmth and nurturance

> Social motives have to do with one's relationships to other people. The desire to affiliate with others is one class of dependable human motivational disposition found in parent-child relations, friendships, and as an important aspect of sex and marriage. Because the teacher is an adult, the affiliative motive often takes the form of dependency that is, the child is the welcome recipient of the warmth and nurturance of the adult. There is evidence that such

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[1] R. F. Berdie, "Scores on the Strong Vocational Interest Blank and the Kuder Preference Record in Relation to Self Ratings," Journal of Applied Psychology, XXXIV (1950), 42-69.

[2] J. C. Gowan, "Intelligence, Interests, and Reading Ability in Relation to Scholastic Achievement," Psychological Newsletter, N.Y.V., No. 8 (1957), pp. 85-87.

[3] C. C. Collins, "The Relationship of Breadth of Academic Interests to Academic Achievement and Academic Aptitude," Dissertation Abstracts, XV (1955), 1782-83.

[4] Travers, op. cit., p. 505.

> warmth and nurturance clearly relates to performances by young children and concept formation, memory, and maze performance, and affects the imitation of irrelevant behavior performed by adults.[1]

These conclusions are supported by the studies[2] of Hartup,[3] Rosenblith,[4] Bandura and Huston,[5] Gewirtz,[6] and Gewirtz and Baer.[7]

b. Ego integrative motives: the achievement motive

> A group of motives that serve to maintain self-confidence and self-esteem have sometimes been referred to as ego-integrative motives. These have been variously characterized as motives of self-actualization[8] or

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[1]P. S. Sears and E. R. Hilgard, Theories of Learning and Instruction, Sixty-third Yearbook of the NSSE (Chicago: The University of Chicago Press, 1964), p. 184.

[2]These studies are cited in Ibid.

[3]Willard W. Hartup, "Nurturance and Nurturance-Withdrawal in Relation to the Dependency Behavior of Pre-School Children," Child Development, XXIX (June, 1958), 191-203.

[4]Judy F. Rosenblith, "Learning by Imitation in Kindergarten Children," Child Development, XXX (1959), 69-80.

[5]Albert Bandura and Aletha C. Huston, "Identification as a Process of Incidental Learning," Journal of Abnormal and Social Psychology, LXIII (1961), 311-18.

[6]Jacob L. Gewirtz, "A Program of Research on Dimensions and Antecedents of Emotional Dependency," Child Development, XXVII (1956), 206-21.

[7]Jacob L. Gewirtz and Donald M. Baer, "The Effect of Brief Social Deprivation on Behavior for a Social Reinforcer," Journal of Abnormal and Social Psychology, LVI (1958), 165-72.

[8]A. H. Maslow, Motivation and Personality (New York: Harper and Brothers, 1954).

> of competence.[1] The achievement motive may be taken as a convenient representative of this group of motives, for it has been the subject of numerous investigations.[2]

Some of the studies related to this category of motives are Child's and Whiting's[3] study on the level of aspiration and McClelland and his associates[4] on achievement motives. Dembo defined the level of aspiration operationally as:

> The level of performance on a familar task which an individual expects to reach. The expectation is defined in terms of the level the individual says he will perform on the task.[5]

Child and Whiting[6] found that: (1) Success generally leads to a raising of the level of aspiration, and failure to lowering. (2) The effects of failure on level of aspiration are more variable than those of success. (3) The

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[1]R. W. White, "Motivation Reconsidered: The Concept of Competence," Psychological Review, LXXVI (1959), 297-333.

[2]Sears and Hilgard, op. cit., pp. 185-88.

[3]L. L. Child and W. M. Whiting, "Determinants of Level of Aspiration: Evidence from Everyday Life," Journal of Abnormal and Social Psychology, XLIV (1949), 303-14.

[4]David C. McClelland, et al., The Achievement Motive (New York: Appleton-Century-Crofts, 1953).

[5]T. Dembo, "Der Arger als Dynamishes," Problem, Psychologische Forschung, XV (1931), 1-144, cited by Travers, op. cit., p. 170.

[6]Child and Whiting, op. cit., pp. 303-14.

greater the success, the greater is the probability of a rise in the level of aspiration; the stronger the failure, the greater is the probability of a lowering in the level of aspiration.

The third category of motives which could be used by teachers is:

c. Curiosity and other cognitive motives

> Among the "neglected drives" that have more lately come to prominence we may recognize a group that can be called cognitive because they are concerned with "knowing" the environment or the relationships among things and ideas.[1]

4. Development and concept formation

a. Evidence is accumulating that learning occurs in two stages. Early learning is slow and involves the acquisition of basic discriminations. Late learning builds rapidly upon the foundation of early learning.[2]

This principle was reached through studies conducted by Hebb,[3] and Melzack and Thompson.[4]

b. While failure to learn at a particular age may be due to the fact that the nervous system may not have developed to the point

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[1]Sears and Hilgard, op. cit., p. 186.

[2]Travers, op. cit., p. 507.

[3]D. O. Hebb, Organization of Behavior (New York: Wiley, 1948); and Introduction to Psychology (Philadelphia: Saunders, 1958).

[4]R. Melzack and W. R. Thompson, "Effects of Early Experience on the Response to Pain," Canadian Journal of Psychology, X (1956), 87-91.

where such learning is possible, an alternative reason may be lack of early learning.[1]

c. The attainment of concepts involves the identification of defining attributes of the class of phenomena included in the concept. Learning the attainment of a concept may be shortened by providing cues concerning the nature of the defining attributes.[2]

The previous principles have the following implications to curriculum development:

a. Since learning occurs in two stages, early learning and late learning, it would be advisable to plan the learning experiences in a way which allows cumulative progression. Major concepts, principles, and conceptual schemes which are to be introduced in late grades should be introduced in a simple way in earlier grades. This would facilitate the learning and provide for continuity of learning experiences. According to Taba:

> The current curriculum has evidently paid too little attention to continuity and reinforcement as the perennial accusation by each level of schooling of the inadequacy of preparation on the preceding level testifies.[3]

b. Children who come from rural areas in Egypt, in general, live in an environment which is less

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[1]Travers, op. cit., p. 507. [2]Ibid.

[3]Hilda Taba, Curriculum Development-Theory and Practice (New York: Harcourt, Brace and World, Inc., 1962), p. 297.

rich due to the lack of electricity, poorer housing, and poorer transportation than those of big cities. The rural schools should have a different curriculum which should provide compensatory enriching learning experiences. Since science is more related to modern equipment and technology, this is especially important.

The Characteristics of the Egyptian Adolescents

This study confines itself to the development of science curriculum in the Egyptian High School. It was mentioned in the first chapter that the high school includes grades seven to twelve--in other words, preparatory schools and secondary schools. The average entrance age of preparatory schools is twelve, which is recognized as the start of the adolescent period in Egypt. The writer finds it important to devote this part of the chapter to characteristics of adolescents. Before reviewing some of the important studies about the Egyptian adolescent, the writer will discuss some universal principles of growth and development. According to Doll, the following are some statements about individual differences in growth and development:

> Many of the obvious differences among learners can be seen in five minutes in any classroom. Other, less obvious differences can be revealed only by careful study.
>
> Learners differ in their ability to perform tasks. Thus a child may be good in arithmetic, poor in

spelling, and fair in reading according to an arbitrary standard of quality. To complicate matters, the same child displays differing abilities in performing specific tasks within each of these school subjects.

Growth and development apparently occur in spurts, sometimes referred to as the "thrustration" involved in pushing forward, with a subsequent period of quiescence and reinforcement following each push.

If individual differences are really taken into account, the school cannot hope to maintain a single or minimum standard for a given group of children, comfortable though this standard might be for teachers. Education should cultivate differences rather than restrict them. If this were done, the range of differences would be more obvious. Though high schools often tend to teach adolescents as though they were all alike, maturation brings out more apparent differences in learners than were present or obvious when the same learners were young children.

Differences in rates of growth, with other factors, cause some children to be "early bloomers" and other children to be "late bloomers."

Given desirable educational conditions, children of whom we have expected little can often give much. Teachers have shown an unfortunate tendency to write off as hopeless those children who have not succeeded well at first.

Since factors of growth are interrelated, the causes of learning difficulty at a given time may be found in some factor which we are not presently considering. For instance, an excellent biology student's sudden block to learning more biology may originate in a hidden emotional upset or physical illness.[1]

Studies on the Egyptian adolescents are very rare. The most important studies we do have are those by Magharous[2]

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[1]Ronald C. Doll, Curriculum Improvement: Decision Making and Process (Boston: Allyn and Bacon, Inc., 1964), pp. 32-35.

[2]Sameol Magharous, "Adwa Ala Almorahek Elmasree": (Lights on the Egyptian Adolescent) (Cairo: 1956).

and Sarhan.[1] The following are some characteristics of early adolescents or, in other words, preparatory school students (grades 7-9):

1. Physical development

   a. They exhibit great variations in rate of development.

   b. A period of fast but uneven growth characterizes the beginning of puberty.

   c. Girls are usually taller and heavier than boys. In many respects they are two years ahead of boys in growth.

   d. Primary and secondary sex characteristics are developing.

   e. Those who are not maturing are more energetic than those who are maturing who might exhibit fatigue.

   f. Features, hands, feet, and legs, are not proportionate due to uneveness of their respective growth.

   g. The heart is not developing as rapidly as the rest of the body.

   h. Awkwardness, poor control, and poor posture often result from uneven growth.

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[1]Eldomerdash Sarhan, "A Comparison of the Interests of Egyptian and American Children," Science Education, XXXIV (1950), 300-306; and Pupils of Secondary Schools--Their Aspirations, Interests, and Problems (Cairo: Dar Elketab Alarabi, 1956).

2. Characteristic reactions

   a. The adolescent seeks acceptance of age-mates. Gangs are still existing. Substantial loyalty to the gang is stronger between boys than between girls.

   b. Those who are maturing begin to show interest in the other sex. Among those who have not yet matured, much teasing and antagonism between boys on the one hand and girls on the other are still existent.

   c. The adolescent may become moody, rebellious, changeable, overcritical, and self-centered.

   d. The adolescent identifies with peers in opinions, values, and attitudes rather than with adults.

   e. The adolescent is self-conscious about body changes.

Sarhan's study indicated that the pupils of the preparatory school differ in interests from those of primary schools as follows:

1. The preparatory school pupil tends to express less interest in material things such as money, jewelry, clothes, housing, food, and different games and dolls. The percentage of those who expressed interest in material things in fifth grade is

18.5 per cent compared to only 6 per cent of those if ninth grade.[1]

2. The preparatory school pupil tends to express more interests in: (1) self-improvement, (2) happiness and benefit for self, and (3) crafts and mechanical arts. Table 3 illustrates the respective percentages of each group.

TABLE 3

MAJOR INTERESTS OF THE PREPARATORY SCHOOL STUDENTS[2]

The object of interest	Fifth grade pupils	Eighth grade pupils
(1) Self-improvement	79.5%	90.6%
(2) Happiness and benefit for self	21.0%	35.3%
(3) Crafts and mechanical arts	11.0%	17.3%

The tested group showed differences in interests due to sex. Girls tended to express less interest than boys relating to material things and recreational activities. On the other hand, a larger percentage of girls than boys expressed wishes pertaining to self-improvement and to people.

[1] Sarhan, "A Comparison," op. cit., p. 301.

[2] Ibid., pp. 301-02.

The implications to preparatory school curriculum development, especially in science, are:

1. Individual differences in capacities and abilities should be met. Special experiences should be provided to give the adolescent a sense of success and to avoid discouragement.
2. The sense of belonging in the peer group encourages establishment of clubs such as the science club and the natural history club.
3. Learning experiences which help the pupil to understand changes in his body should be provided. This might lead to a better acceptance of the irregularities of both physical and emotional growth.

When considering secondary school students (grades 10-12), the following are their characteristics:

1. Physical development
   a. Most pupils have matured by age fifteen with accompanying physical and emotional changes.
   b. The period of uneven growth is passing.
   c. The pupil appears more like an adult.
   d. The heart is still increasing substantially in size.
   e. The interest in the other sex is fully developed.
   f. The energy level is unstable.
2. Characteristic reactions
   a. The adolescent exhibits mood swings. For

example, sometimes he is cooperative and responsible and other times he is rebellious and defiant.

b. He is anxious about his own physical appearance.

c. He is often looking for ideals and standards and is anxious about his future.

d. He strives to be popular.

e. He fears ridicule and criticism.

f. He strives to be accepted by peers, especially girls.

f. He desires responsibility and takes it, especially in peer groups, and wants the independence of earning his own money.

Sarhan found that students in secondary school differ from those in preparatory school in the following:

1. Fewer students of secondary school express interest in material things than those in preparatory school (7.0 per cent vs. 11.5 per cent).[1]

2. Fewer students in secondary school indicated that subject matter is the thing they like best in school (5 per cent of secondary school vs. 54.0 per cent of preparatory school).[2]

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[1]Sarhan, Pupils of Secondary Schools, op. cit., p. 23.

[2]Ibid., p. 60.

The following are the reasons of disinterest in subject matter as indicated in the study:

1. Subject matter content is too long and the student needs a lot of root learning to prepare for tests.
2. Curricula are not related to the students' lives. The benefit of studying them is not clear to the student.
3. The teacher-student relationship is bad. The teacher's method does not fit the student.
4. Lecture method is dominating. Experimental work is far from good. Audio-visual aids are not used.
5. Textbooks are difficult to comprehend and are not interesting.
6. Failure in examinations.[1]

3. Fewer students in this stage than in the previous one express wishes to pass examinations (29.25 per cent vs. 72.8 per cent).[2]

4. The secondary school student aspires more than the preparatory school student for independence in earning his own money and in decision making (24.5 per cent vs. 16.8 per cent).[3]

5. Secondary school students are more preoccupied with people's acceptance (86 per cent vs. 58 per cent).[4]

The implications to secondary school curriculum development, especially in science, are:

1. Desirable learning experiences

   a. Sarhan's study indicated that the secondary school students expressed a need to learn about:

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[1]*Ibid.*, p. 62. [2]*Ibid.*, p. 98.

[3]*Ibid.*, p. 99. [4]*Ibid.*, p. 107.

Human physiology--How to improve my hygiene? Diseases and how to avoid them--Sexual drive and how to control it--Masturbation--Nutrition.[1]

b. The secondary school students indicated the physics courses are long and difficult, and the topics are unrelated and not meaningful.[2] Better planning for integration of meaningful learning experiences is needed. The mere accumulation of sophisticated facts does not produce a "good"-"rich" curriculum.

2. Behavioral goals and desirable values and attitudes

   a. To provide learning experiences which allow the student to work with the group and to accept responsibility.

   b. To enable the student to select a career.

   c. To allow the student to learn to discuss intelligently, to respect the views of others, to change his point of view if proved wrong, and to report honestly to others.

   d. To give every student a chance to select a hobby by participating in different clubs.

The Nature and Structure of Science--Research on Science Teaching

It is appropriate to start this examination of the nature of science by stating some definitions of it.

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[1]*Ibid.*, p. 70. [2]*Ibid.*, p. 72.

Einstein sees science as laws seeking discipline. "Science is the attempt to make the chaotic diversity of our sense experience correspond to a logically uniform system of thought."[1] A similar definition will be that of Campbell. "Science is the study of these judgements concerning which universal agreement can be obtained."[2] On the other hand, Conant emphasizes the process of experimentation and observation:

> 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.[3]

Some of the previous definitions describe science merely as the discovery of relationships while others focus on the processes of inquiry involved.

The nature and structure of disciplines have received much attention by educators in the past decade as one source of information about curriculum planning. Bruner is very often considered the pioneer of this trend. As stated by Ford and Pugno:

> The beginning is difficult to determine, but certainly Bruner's The Process of Education[4] was most

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[1]Albert Einstein, "Considerations Concerning the Fundamentals of Theoretical Physics," Science, IX (1940), 487.

[2]Norman Campbell, What Is Science? (New York: Dover Publications, 1952), p. 27.

[3]James B. Conant, Science and Common Sense (New Haven and London: Yale University Press, 1963), p. 25.

[4]Jerome S. Bruner, The Process of Education (Cambridge: Harvard University Press, 1962).

timely and focused attention on the concept of structure as related to learning.[1]

What then is the definition of the term "structure"? According to Schwab:

> Structure is not a difficult concept. It refers to the parts of an object and the ways in which they are interrelated. The structure of a molecule would be its atomic constituents and the ways the atoms are arranged. The structure of a curriculum would be the various subjects and educational activities and their vertical and horizontal arrangement.[2]

Bruner describes the structure of a discipline by identifying the process of understanding it.

> Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related.[3]

Many educators and scientists advocate teaching the fundamental structure of a subject. Bruner supplies four general claims as a rationale for doing this.

> The first is that understanding fundamentals makes a subject more comprehensible. . . .
> The second point relates to human memory. Perhaps the most basic thing that can be said about human memory, after a century of intensive research, is that unless detail is placed into a structured pattern, it is rapidly forgotten. . . .
> Third, an understanding of fundamental principles and ideas appears to be the main road to adequate transfer of training. . . .
> The fourth claim for emphasis on structure and principles in teaching is that by constantly re-examining material taught in elementary and secondary schools for its fundamental character, one is able to

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[1]G. W. Ford and Lawrence Pugno (eds.), The Structure of Knowledge and the Curriculum (Chicago: Rand McNally and Co., 1964), p. 1.

[2]Ibid., p. 2.

[3]Bruner, op. cit., p. 37.

> narrow the gap between "advanced" knowledge and "elementary" knowledge.[1]

It is important to sit back and identify the major questions which ought to be answered in studying the structure of disciplines. Schwab indicates that there are three sets of problems.

> The problem of determining the membership and organization of the disciplines, of identifying the significantly different disciplines and of locating their relations to one another. . . .
>
> The second set of problems of the structure of the disciplines is to identify these structures and understand the powers and limits of the enquiries that take place under their guidance. Let us call this set of problems the problem of the substantive structures of each discipline.
>
> Thirdly, the problem of determining for each discipline what it does by way of discovery and proof, what criteria it uses for measuring the quality of its data. . . .[2]

The following is a review of studies dealing with the problems Schwab has suggested concerning the structure of science. The most important of these studies is that conducted by Robinson in Stanford University.[3] Robinson analyzed six writings concerned with the nature

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[1] *Ibid.*, pp. 23-26.

[2] Joseph J. Schwab, in Ford and Pugno, *op. cit.*, pp. 10-14.

[3] James T. Robinson, "Science Teaching and the Nature of Science," *Journal of Research in Science Teaching*, I (1965), 37-50.

and structure of knowledge in physical and biological sciences.[1]

Robinson identified two categories of science: correlational sciences and exact sciences.

> Correlational procedures are characterized by data collection and by comparisons. Such comparisons may result in groupings or classifications, for example, the grouping of organisms into categories of plants, animals or protists. Correlation of quantitative data may result in a mathematical relation, the correlation coefficient, developed by agreed-upon rules of procedure. The biological sciences are characterized by correlational procedures. The inductive generalizations resulting from these procedures may summarize or describe, but they do not predict, and thus do not seem to satisfy investigations as they search for basic explanations.[2]

On the other hand, Robinson states that the characteristics of the exact sciences are:

> . . . a basic set of generalizations presented with formal symbolisms and rules of procedures by which one

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[1]These books are:

Henry Margenau, The Nature of Physical Reality (New York: McGraw Hill, 1950).

Philipp Frank, Philosophy of Science--The Link Between Science and Philosophy (Englewood Cliffs, N.J.: Prentice Hall, 1957).

Percy W. Bridgman, The Nature of Science of Our Physical Concepts (New York: Philosophy Library, 1952).

J. H. Woodger, Biology and Language (Cambridge: Cambridge University Press, 1959).

Morton Beckner, The Biological Way of Thought (New York: Columbia University Press, 1952).

Ralph W. Gerard (ed.), "Concepts of Biology," Behavioral Science, XIII (1958), 93-215.

[2]Robinson, op. cit., p. 38.

> may go back to the specific instances that are suggested by the general principles.[1]

Robinson considers physics a good example of exact sciences. Robinson explains the organization of thought in the physical sciences as an example of the process of inquiry in an exact science. Figure 3 might be helpful in understanding the following illustration:

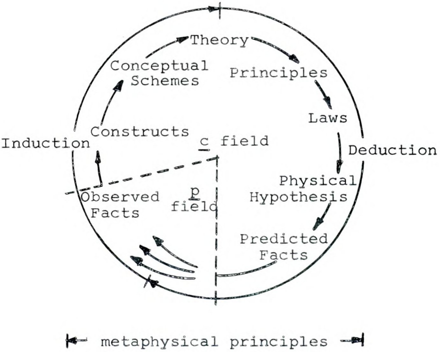

Fig. 3.--A Schemata of the Organization of Thought in the Physical Sciences[2]

> Verification proceeds from the p field through operational definitions to the field c with its network of accepted constructs where it moves into what are generally referred to as deductive processes--the prediction of new and non trivial observations in the field. The predicted observations must fall within the

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[1] Ibid., p. 39.

[2] Ibid., p. 42.

probability prescribed by the theory of which they are a part. When this circuit is successfully completed, the entire set of constructs involved is said to be verified.[1]

Schwab came up with a similar summary of what he calls the short-term syntax of sciences.

1. The formulation of a problem. . . .
2. The search for data that will suggest possible solutions to this problem.
3. Reformation of the problem to include these possible solutions.
4. A determination of the data necessary to solve the problem.
5. A plan of experiment that will elicit the data desired.
6. Execution of the experiment and accumulation of the desired data.
7. Interpretation of the data by means of the guiding substantive structures together with previous knowledge possessed by the investigator.[2]

Conant discusses what he calls "tactic and strategy of science." The following principles summarize what he means by this.

> New concepts may result from systematic experiments or observations and are fruitful of new experiments or observations. . . .
>
> Significant observations are the result of "controlled experiments" or observations; the difficulties of experimentation must not be overlooked. . . .
>
> New techniques arise as a result of experimentation and influence further experimentation.[3]

The structure of science should not be overlooked as one of the bases of science curriculum development.

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[1] Ibid.

[2] Schwab, op. cit., pp. 38-39.

[3] James B. Conant, On Understanding Science (New York: New American Library of World Literature, 1958), pp. 104-108.

The writer deems it important to include the Egyptian scientists jointly with educators in identifying the fundamentals of the different sciences and their methods of inquiry. Curriculum planners would then select from these fundamentals those they might deem appropriate to achieve the social goals and meet the student's needs and development.

This part of the chapter is devoted to literature on science education. The main considerations dealt with here are: (1) objectives, (2) selection of learning experiences and content placement, (3) methods of teaching, and (4) the process of evaluation. The writer was met in some of these areas by scarcity or lack of research in the Egyptian schools. A comparative study is deemed legitimate to discover deficiencies and to shed some light on needed research and actions.

Objectives of Science Teaching in Preparatory and Secondary Schools

It seems advisable to start by reviewing the objectives of general education in these two stages. The objectives of the Egyptian preparatory schools as stated by Samaan and Labeeb are:

> . . . (1) to strengthen the national culture by acquainting the pupils with it in a way which would help them to criticize and improve it, (2) to help the pupils pass from childhood to maturity and adulthood .

. . (3) to identify their interests and talents and guide them to the suitable kind of secondary school.[1]

The objectives of the secondary school are controversial and very vague. As Samaan and Labeeb describe the situation:

> The problem of objectives of the secondary school is still faced. Some consider the secondary school a stage preparing for the university, some others consider it a stage of general education which aims to prepare the student for life in addition to his preparation for the university. This vagueness of objectives crippled curricula, led to their disintegration and impeded the school from achieving its objectives.[2]

It is obvious that a conscious effort to define the objectives of the secondary school is lacking. The rationale developed in the next chapter in addition to the criteria of selecting objectives hopefully will be instrumental in identifying objectives of teaching science in the secondary schools.

Let us consider the objectives of teaching science in the preparatory school. Mr. Hanna reports these objectives as follows:

> (1) to develop in the student the ability to observe scientifically and precisely and to initiate their appreciation to this scientific age, (2) to provide them with information which would help them understand natural phenomena, control the environment, and benefit from it, (3) to illustrate the role of science in economic growth, (4) to help the students understand the physiology of the human body and habits of good hygiene, (5) to illustrate the role of science

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[1]W. E. Samaan and R. Labeeb, Studies in Curricula (Cairo: The Anglo-Egyptian Library, 1959), p. 276.

[2]Ibid., p. 277.

in introducing favorable health conditions in the nation, (6) to develop the student's ability to use the scientific method of thinking, (7) to provide the students with some experiences in using scientific attitudes, (8) to allow them to select a scientific hobby.[1]

Four faculty members of the College of Education of EinShams University presented the following as goals which the teaching of science should try to achieve:

> The teaching of science ought to be aimed at (1) helping the individual to adjust successfully to his continuously changing environment--coping with change when it occurs, (2) helping every individual to participate in solving national problems and increase its prosperity. This could be achieved by studying the role of science in social progress. Accordingly, the teaching of science in all stages should try to achieve the following objectives: (a) to provide the students with functional information, . . . (b) to help them acquire certain skills, . . . (c) to develop in them suitable scientific interests in a functional way, . . . (d) to help them acquire functional scientific attitudes, . . . (e) to have them appreciate science and scientists, . . . (f) to allow them to practice the scientific method of thinking.[2]

This set of objectives is similar to that advocated by the forty-sixth yearbook of the NSSE as objectives of science education in the U.S.A.[3] This includes:

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[1]E. Hanna, "Science Curricula in the Preparatory School and Their Role in Achieving the Goals of this Stage," A paper presented to the Fourth Convention of the Arab Teachers in Alexandria, U.A.R., August, 1965, pp. 3-4. (Mimeographed.)

[2]S. Kotb, *et al.*, "Objectives of Teaching Science," A paper presented to the Fourth Convention of the Arab Teachers in Alexandria, U.A.R., August, 1965, pp. 3-9. (Mimeographed.)

[3]National Society for the Study of Education, *Science Education in American Schools*, The Forty-Sixth Yearbook (Chicago: The University of Chicago Press, 1947), pp. 28-29.

(1) functional information or facts, (2) functional concepts, (3) functional understanding of principles, (4) instrumental skills, (5) problem solving skills, (6) attitudes, (7) appreciations, and (8) interests. At the same time, it exhibits great similarity to that set of objectives proposed by the fifty-ninth yearbook of the NSSE.

> As the educator looks at science education in its historical perspective, there are certain aims stressed in the earlier writings with which he cannot agree, as, for example, the generalized training of the mind. But he finds no quarrel with the emphasis on scientific methods and procedures, with the understanding of principles and the interpretation of generalizations, or with sincere attempts to make science functional in the lives of students; nor does he belittle an increased interest in science, the development of scientific attitudes, the overcoming of superstition and prejudice, the tolerance of uncertainty, the development of original and independent thinking, or the acquisition of knowledge about scientific phenomena.[1]

Selection of Learning Experiences and Content Placement

Studies for selection of science content and its placement in different grades are very rare in Egypt. The most important of those studies were those by Paulos[2] and

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[1]National Society for the Study of Education, Rethinking Science Education, The Fifty-Ninth Yearbook, Part I (Chicago: The NSSE, 1960), p. 27.

[2]Sami I. Paulos, "Using the Scientific Approach in Constructing a Course in Biology for the Senior High Schools in Egypt," Science Education, XLVI (1962), 442-47.

Bebawey.[1] Paulos used a questionnaire to identify the topics of biology which might interest the secondary school students. The results of the questionnaire were used in establishing a new introductory course of biology. Bebawey used another technique in determining the content of general science courses for the preparatory school. Certain topics were suggested by the author as a result of a rationale developed after reviewing some social problems. A questionnaire was developed to investigate the opinions of educators and subject matter specialists about the significance of each topic. The problem of the placement of these selected topics was not considered.

Similar attempts have been made in the planning of science content in the U.S.A. Cohen states that:

> Studies seeking to identify appropriate course content for various grade levels have utilized techniques such as studies of existing textbooks, children's expressions of interests, surveys of school systems and teacher groups to determine their present practices, and opinions of juries of subject matter.[2]

The current trend in selection of content of science curricula in the U.S.A. is to rely upon scientists in identifying the fundamentals of the discipline. Educators participate in the process of selection, organization, and trial of content. This has been done in studies such

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[1]Bebawey, loc. cit.

[2]David Cohen, "The Development of an Australian Science Model," Unpublished dissertation at Michigan State University, 1964, p. 103.

as the Physical Science Study Committee (PSSC), the Biological Sciences Curriculum Study (BSCS), the Chemical Bond Approach Project (CBA), and the Chemical Education Materials Study (CHEMS). A brief review of some of these studies might be helpful for comparative purposes in the development of science curricula in the preparatory and secondary schools of the U.A.R.

1. Physical Science Study Committee (PSSC)

The Physical Science Study Committee, including scientists and teachers, adopted the task of developing an introductory course for high school physics. The identification of fundamental concepts was accompanied by the development of textbooks, laboratory manuals, and an excellent set of films. The course content includes four main parts, each one building on the preceding. Part I includes concepts of time, space, and matter; Part II deals with a detailed study of light; Part III with motion; and Part IV with electricity and the physics of the atom. The PSSC course emphasizes, as Goodlad states:

> the basic structure of physics, the acquisition of new physical knowledge, and the necessity for understanding rather than memorizing basic physics concepts. A central concept is the laboratory in which students gain first-hand experience in discovering and verifying physical phenomena. The program contains fewer facts than are usually included in an elementary

> physics course, but concepts are to be understood and used, not just asserted.[1]

Since the PSSC program has different objectives of conventional physics courses, the committee deemed it unjust to use the conventional tests for evaluation or comparative purposes.

2. Biological Sciences Curriculum Study (BSCS)

The committee which conducted this study was struck by the fact that most of the biology courses are lagging twenty to one hundred years behind the recent biological advances. They decided that new curricula should include fundamental concepts rather than a mere encyclopedic collection of facts. Nine concepts were selected: changes of living things through time (evolution); diversity of type and unity of pattern of living things; genetic continuity of life; biological roots of behavior; complementarity of organisms and environment; complementarity of structure and function; regulation and homeostasis--the maintenance of life in the face of change; science as inquiry; and intellectual history of biological concepts. The same concepts are dealt with in three versions, a

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[1] John I. Goodlad, School Curriculum Reform in the U.S. (New York: The Fund for the Advancement of Education, 1964), pp. 23-24.

Green, Yellow and Blue version, each of which uses a different approach.

> The Green version emphasized the biological community, beginning with the complexity and diversity of life and coming to cellular structure relatively late in the course. Major topics are the following: the biosphere dissected; patterns in the biosphere; the individual dissected, evolution, behavior, and man. The Yellow version, emphasizing cellular biology at the outset, divides the subject-matter into seven sections: cells, microorganisms, plants, animals, genetics, evolution, and ecology. The Blue version stresses physiological and biochemical evolutionary processes, with emphasis on the contributions that molecular biology has made to the general understanding of the universe. Topics are: biology--the interaction of facts and ideas; evolution of the cell; the evolving organism, multicellular organisms--energy utilization, multicellular organisms--integrative systems; higher levels of organization.[1]

3. Chemical Bond Approach (CBA)

The goal of the study is expressed by Laurence Strong, its director, as follows:

> The Chemical Bond Approach Project is an attempt to develop an introductory chemistry course which presents modern chemistry to beginning students. The presentation is intended to give students a preliminary understanding of what chemistry is about, rather than simply an encyclopedic collection of chemical reactions and laboratory techniques, or a mere overview of diverse conclusions held by chemists today. Such a course must be an organized one in which the pattern reflects the structure of the discipline itself.[2]

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[1] *Ibid.*, pp. 26-27.

[2] Laurence E. Strong, "Facts, Students, Ideas," *Journal of Chemical Education*, XXXIX (March, 1962), 126.

The central theme of CBA is the study of chemical bonds, their making and their breaking between atoms. The student is always confronted with a problem solving situation. The study of the atom and its reactions to him is similar to the study of "a black box." Depth in treatment of basic concepts and principles is substituted for the mere shallow study of many facts. Open-ended experiments are substituted for the conventional cook-book approach to laboratory work.

The writer found that research on the placement of different concepts at different grade levels is very rare. This was stated by the committee of the fifty-ninth yearbook of the National Society for the Study of Education as follows:

> Definitive research regarding the nature of science concepts that can be learned by pupils at each grade level is lacking.[1]

The following questions about grade placement were raised by Doll.

> What subject matter should be moved up the grade scale? What should be moved down? What can children learn that has heretofore seemed beyond their capabilities? These are a few of the questions to which more and more answers are being sought.[2]

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[1]National Society for the Study of Education, Rethinking, op. cit., p. 158.

[2]Doll, op. cit., p. 77.

Research on Methods of Teaching Science

The writer is confronted by the fact that no substantial research has been conducted on methods of teaching science in the Egyptian preparatory and secondary schools. The next few years will witness the trend toward testing the significance of different methods in achieving the different objectives of science teaching. The following review of research on methods of teaching in the U.S. might help the researchers identify some researchable problems. In the next few pages the writer will review some studies about: (1) the role of laboratory work in science teaching, (2) teaching scientific thinking, and (3) studies which compare two methods of teaching.

1. The role of laboratory work in teaching science

Whenever the development of the scientific method of thinking, teaching of scientific attitudes, and mastery of scientific skills are among the objectives of teaching science, laboratory work comes to the front as a way of fulfilling these objectives. Carlton considers laboratory work the heart of science teaching.

> But when the laboratory and its emphasis on the investigative or research-type exercise disappears from day-in, day-out science teaching, then the heart and chief inspiration of

> science as a form of human endeavor have been lost.[1]

In a review of literature on laboratory work up to 1945, Cunningham[2] found that adequate statistical analysis is lacking and the reliability of results was not indicated. Most of these studies used conventional paper-and-pencil tests to compare the laboratory methods with non-laboratory or demonstration methods. Kruglak conducted a study to compare the performance and achievement of physics students with and without laboratory work. The following conclusions were reached:

> The experimental evidence of this investigation supports the conclusion that students who got laboratory instruction, by the individual or demonstration method, are superior to students without such instruction, on tests designed to measure laboratory outcomes.
>
> Since no significant differences between the means of any two groups were found for the mechanics theory test, it is reasonable to conclude that laboratory instruction does not significantly influence scores on pencil-paper tests designed to measure a knowledge of facts, principles, and applications of elementary mechanics.[3]

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[1]Robert H. Carlton, "Physics Hazard, Math Hazard, or Teacher Hazard," The Science Teacher, XXII (September, 1955), 173-75.

[2]H. A. Cunningham, "Lecture Method Versus Individual Laboratory Method in Science Teaching," Science Education, XXX (1946), 70-82.

[3]H. Kruglak, "Achievement of Physics Students With and Without Laboratory Work," American Journal of Physics, XXI (1953), 15.

The results of the previous study concerning achievement is confirmed by Humphreys' study:

> The study revealed that a planned laboratory program does not affect the scores of students on achievement or interest instruments at statistically significant levels.[1]

Watson reports a significant study conducted by Lahti:[2]

> Lahti, in a collegiate physical science course, explored the effect of various approaches in laboratory work. . . . All students had the same lectures, and they showed no significant differences on tests covering the lectures.
>
> For laboratory work, about one hour per week, four approaches were used: (1) individual or small-group efforts by an inductive-deductive or problem-solving approach in which the answer sought was not known; (2) a case-history approach in which the answer sought was known; (3) a "theme" approach later changed to a discussion recitation session; and (4) a standard "get the right answer" approach. Apparently the students proceeded throughout a year by one of the four approaches.[3]

While Lahti did not find any statistically significant differences, the group which used approach (1), problem solving in the laboratory, scored

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[1] Alan H. Humphreys, "A Critical Analysis of the Use of Laboratories and Consultants in Junior High School Science," Dissertation Abstracts, XXIII, Pt. II (1962), 1623.

[2] M. Lahti, "The Inductive-Deductive Method and the Physical Science Laboratory," Journal of Experimental Education, XXIV, 149-63.

[3] Fletcher G. Watson, "Research on Teaching Science," Handbook of Research on Teaching, ed., N. L. Gage (Chicago: Rand McNally and Company, 1963), p. 1042.

highest on his three tests: Interpretation of Data, Design-An-Experiment Test, and Performance Test.

Kruglak and Goodwin[1] conducted a study to test laboratory achievement related to the number of partners. They investigated laboratory achievement of Naval Academy midshipmen, working singly, in pairs, and in quartets. No significant differences in the means of the three groups were found on two laboratory tests. The quartet groups had significantly higher laboratory grades, based on reports written in the laboratory. This might be due to the cooperative effort exhibited.

Laboratory work has always been considered important for the secondary school students by science educators in the U.A.R. Table 4 indicates the status of laboratory facilities in preparatory and secondary schools. More laboratories should be established in the schools which lack them. Laboratories should be provided with up-to-date equipment and materials.

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[1]H. Kruglak and Ralph A. Goodwin, "Laboratory-Achievement in Relation to the Number of Partners," American Journal of Physics, XXIII (1955), 257-64.

TABLE 4

COMPARATIVE STATISTICS OF LABORATORIES, IN GOVERNMENT SCHOOLS (EXCLUDING COMMERCIAL SCHOOLS AND PRIMARY SCHOOLS) IN FOUR YEARS 1957-1961

School Year	No. of School Buildings	Amphitheatre				Laboratories				Lab Assistant		
		Having no Amphs	Having one Amph	Having two Amphs	Having more than two	Having no Labs	Having one Lab	Having two Labs	Having more than two	Having no	Having one	Having more than one
1957-1958	791	469	216	45	61	210	390	94	97	420	286	85
1958-1959	812	474	227	46	65	148	443	134	87	354	339	119
1959-1960	837	496	231	46	64	113	492	107	125	334	370	133
1960-1961	859	524	223	48	64	72	567	90	89	328	386	145

Excluding Laboratories for Preparatory and Secondary Agricultural Schools

2. Teaching scientific thinking, problem solving, and scientific attitudes

Most educators resist considering science merely as an encyclopedic collection of facts. The processes of inquiry and methods of thinking are always emphasized.

> When it comes to the teaching of science it is perfectly clear where we, as science teachers, science educators, or scientists stand: we are unalternably opposed to the rote memorization of the mere facts and minutiae of science. By contrast, we stand four square for the teaching of the scientific method, critical thinking, the scientific attitude, the problem solving approach, the discovery method and of special interest here, the inquiry method. In brief, we appear to agree upon the need to teach science as process or method rather than as content.[1]

Mason suggested treating the previous terms as synonymous.[2] Keeslar suggests the following list of scientific attitudes:

> Desire to try things out experimentally, belief in cause and effect, rejection of superstitions as a basis for thinking, determination to be careful and accurate in all one's observations, willingness to change an opinion or conclusions because of later evidence, determination to be objective in judgement, and

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[1] F. J. Rutherford, "The Role of Inquiry in Science Teaching," Journal of Research in Science Teaching, II (1964), 80-84.

[2] John M. Mason, "An Experimental Study in the Teaching of Scientific Thinking in Biological Science at the College Level," Unpublished Ph.D. dissertation at Michigan State College of Agriculture and Applied Science, 1951, p. 20.

> unwillingness to base a conclusion on one, or a few observations.[1]

Many studies have been conducted to identify behaviors related to problem solving skills and how to teach them. Meridith[2] conducted a study to compare the effectiveness of two methods of developing problem solving ability. The experimental group studied principles related to the basic organizing concept "energy can be transformed from one form to another." The control group studied a descriptive survey of physical science. The study provided the following conclusions:

> Conceptually related science subject matter content is more suitable for instruction directed toward the goal of gain in problem solving ability than the more usual topic presentation of subject matter.
>
> The ability to solve science problems is highly correlated with knowledge of science facts and principles.[3]

Kahn conducted a study to test a certain method of teaching scientific attitudes to seventh and eighth grade boys. The control group was acquainted with thirteen scientific attitudes for a period of an hour. In the next hour, both the experimental

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[1]Oreon Keeslar, "The Science Teacher and Problem Solving," The Science Teacher, XXIII (February, 1956), 14.

[2]Charles Earling Meridith, "Development of Problem Solving Skills in High School Physical Science," Dissertation Abstracts, XX, Pt. 4, No. 10 (1962), 3550.

[3]Ibid.

and control group discussed one science news article. This was followed for the experimental group only by an analysis to determine what attitudes were illustrated in the article. The experimental group scored significantly higher on tests of scientific attitudes than did the control group.[1] Katz found that a group of educable retardates who learned by a problem solving method significantly demonstrated that they were better able to solve problems based on learned principles than the group who learned by rote.[2]

3. Studies which compare two methods of teaching

A typical approach of research on methods of teaching is to compare the effectiveness of two teaching methods in achieving certain objectives. Examples of these studies are found under a common category in which two methods of performing experiments in laboratories are compared. Charen compared the open-ended approach to performing experiments to the traditional cook-book approach in

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[1]Paul Kahn, "An Experimental Study to Determine the Effect of a Selected Procedure for Teaching the Scientific Attitude to Seventh and Eighth Grade Boys through the Use of Current Events in Science," Science Education, XLVI, No. 2 (March, 1962), 115.

[2]Paul J. Katz, "Transfer of Principles as a Function of a Course of Study Incorporating Scientific Method for the Educable Mentally Retarded," Dissertation Abstracts, XXIII, Pt. 4 (1963), 42-44.

relation to the student achievement and critical thinking. Charen defined "open-ended experiments" as:

> experiments which require students to seek solutions to problems using a method similar to that of genuine scientific inquiry. The outcomes cannot be anticipated before the start of the experiments. . . . The pupils are encouraged to record exactly what is observed and are not penalized for failure to obtain accepted results.[1]

On the other hand, "traditional laboratory experiments" were defined as:

> experiments which usually, but not necessarily are designed to illustrate and verify facts and principles already taught to the students in the classroom and readily available in the textbook. Specific and detailed directions are provided which pupils are expected to follow.[2]

Results indicated that the experimental group did significantly better in achievement tests. But for critical thinking in chemistry, neither method evidenced a significant difference in gains. The over-all results of the comparisons of the I.Q. subcategories indicated that no significant gains were made by any I.Q. level after experiencing either laboratory method. Karle obtained different

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[1]George Charen, "The Effect of Open-Ended Experiments in Chemistry on the Achievement of Certain Objectives of Science Teaching," Journal of Research in Science Teaching, I (1963), 184.

[2]Ibid.

results in a similar study.[1] Karle found no significant difference between open-ended method and the conventional laboratory exercises in developing critical thinking, interest in science, recall of principles, and the quantitative application of principles. Mark's study was in the same line of the preceding two studies. The experimental group in Mark's study devised methods of solving ten problems given to them, while the control group performed the same ten problems using laboratory manuals. The experimental group recorded their results on special experiment sheets in the form of observations, equations, calculations, diagrams, and conclusions. On the other hand, the control group recorded their results on blanks provided for this purpose in the manuals. Results indicated that:

> Both groups performed equally well in the mastery of unrelated facts, principles, problems, equations, and symbols of chemistry regardless of the procedures used during laboratory periods.[2]

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[1] Irmgard F. Karle, "A Comparison of Open-Ended Chemistry Experiments with the Conventional Laboratory Exercises in Teaching Selected High School Chemistry Classes," Research in the Teaching of Science, ed., Lloyd M. Johnson (Washington, D.C.: U.S. Government Printing Office, 1965), p. 58.

[2] Steven J. Mark, "Experimental Study Involving the Comparison of Two Methods of Performing Experiments in High School Chemistry," Science Education, XL (December, 1961), 412.

The experimental group surpassed at the three per cent level of confidence the control group in interpreting chemistry knowledge expressed in the form of paragraphs and diagrams.

The following paragraphs review a category of studies comparing lecture-demonstration method with some other methods. Mahan's study tried to answer the following question:

> What differences in regard to the attainment of instructional outcomes are there between the lecture discussion and problem-solving methods of teaching science when used to instruct college preparatory ninth grade students?[1]

No differences were found in the development of scientific attitudes by the use of the two methods. Students in the lower ability ranges acquired superior growth in science knowledge, problem solving skills and in mechanical interests when instructed by a problem solving method.

Strehle compared the achievement of seventh-grade students taught by laboratory versus enriched lecture-demonstration methods of instruction.

> The enriched lecture-demonstration group actually showed a larger percentage gain in

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[1]Luther Alvin Mahan, "The Effect of Problem-Solving and Lecture-Discussion Methods of Teaching General Science in Developing Student Growth in Basic Understandings, Problem-Solving Skills, Attitudes, Interests, and Personal Adjustment," Dissertation Abstracts, XXIV, No. 3 (1963), 1097.

> mean raw score points than did the laboratory group.[1]

Oliver carried on a study to determine the relative effectiveness of the following three methods of teaching: (1) lecture-demonstration, (2) lecture-discussion, (3) lecture-discussion-demonstration-laboratory experiences. No significant differences occurred among the groups on measures of factual information, over-all achievement in biology, application of science principles, or attitudes toward science and scientists.[2]

It is obvious that most of the studies comparing two methods of teaching lack reliability and oftentimes contradict each other. Wallen and Travers indicated that this technique of research is giving way to a better designed research:

> The era of research involving the comparison of one teaching method with another seems to be coming to a close. At the public school level, few studies have been undertaken during the last two decades, perhaps because the "disappointing" results have failed to reinforce the behavior of investigators. . . . Research workers must surely go back, take stock of their position,

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[1] Joseph Albert Strehle, "The Comparative Achievement of Seventh Grade Exploratory Science Students Taught by Laboratory Versus Enriched Lecture-Demonstration Methods of Instruction," Dissertation Abstracts, XXV, Pt. 2 (1964), 2388.

[2] Montague M. Oliver, "An Experimental Study to Compare the Relative Efficiency of Three Methods of Teaching Biology in High School, Dissertation Abstracts, XXII, No. 7 (1962), 2293.

> and realize that the starting place must be the systematic design of teaching methods.[1]

The close similarity in effectiveness of different teaching methods is explained by Wallen and Travers as follows:

> Different teaching methods emphasize different principles of learning and neglect others. Since this is the case, there is little likelihood that any one is superior to any other when the over-all effects of teaching are appraised. The best one might hope for would be slight differences in teaching effectiveness within narrow aspects of the learning process, and this is roughly what is found by empirical research.[2]

If the previous review of research on methods of teaching in the U.S. implies something to needed research in the U.A.R., it would imply the following:

1. Studies conducted to prove the superiority of one teaching method to any other method in achieving the over-all objectives very oftentimes stem from some personal biases. The Egyptian educational system suffered in part from acts requiring teachers to use a certain teaching method "per se." An example of this was the generalization of the sentence method in reading in all the elementary schools of the U.A.R.

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[1]Norman E. Wallen and Robert M. W. Travers, "Analysis and Investigation of Teaching Methods," Handbook of Research on Teaching, ed., N. L. Gage (Chicago: Rand McNally and Company, 1963), p. 494.

[2]Ibid., p. 500.

2. Research on teaching methods which will contribute to an organized body of scientific information requires that teaching methods themselves be designed systematically in terms of empirically established learning principles.[1]

The Process of Evaluating the Student's Development in Science

It is unfortunate that the term "evaluation" is very often viewed as synonymous with testing by most of the teachers and educators in the U.A.R. In spite of the fact that some behavioral objectives are included in the list of objectives of teaching science, teachers, students, and parents continue to emphasize retention of facts for examination.

> So long as pupil accomplishment and, inevitably, teacher success are defined in terms of narrowly conceived achievement examinations, teachers will center their explicit instructional purposes around the limited kinds of tasks required in these examinations. Or conversely, they will not be willing to invest much effort in other types of objectives.[2]

The process of evaluation will be dealt with in more detail in the next chapter. A comprehensive evaluation program will be proposed as a part of the rationale developed.

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[1] *Ibid.*, p. 493.

[2] Watson, *op. cit.*, p. 1034.

CHAPTER IV

A MODEL FOR THE DEVELOPMENT OF THE SCIENCE CURRICULUM IN THE EGYPTIAN PREPARATORY AND SECONDARY SCHOOLS

The development of a curriculum includes four major processes. These processes are: selection of objectives, identification of learning experiences and suitable content, organization of learning experiences, and evaluation. The previous attempts for the development of science curricula in the U.A.R. failed to develop a rationale for selections and decisions concerning the previous four processes. According to Taba:

> . . . if curriculum development is to be a rational and a scientific rather than a rule-of-thumb procedure, the decisions about these elements need to be made on the basis of some valid criteria.[1]

This chapter is an attempt to develop criteria for selection of objectives and learning experiences, and for organization of learning experiences and evaluation. But what are the main sources of information which should guide the process of selecting these criteria? Taba explains:

> . . . scientific curriculum development needs to draw upon analyses of society and culture, studies of

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[1]Taba, op. cit., p. 10.

> the learner and the learning process and analyses of the nature of knowledge in order to determine the purposes of the school and the nature of its curriculum.[1]

Chapter III focused on analyzing the previous three foundations of curriculum. This chapter will state the criteria which should guide decisions in curriculum development.

Criteria for Formulating Objectives

The following criteria should be considered in formulating objectives:

1. Are the objectives clearly defined in terms of behavioral change in the student?

   This criterion stems from the definition of learning as a change of behavior. Tyler stated that:

   > Education is a process of changing 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.[2]

   Thus, the objective should be stated from the standpoint of pupil behavior rather than of teacher behavior.[3] Instead of saying, "to teach the

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[1] Ibid.

[2] Ralph W. Tyler, Basic Concepts of Curriculum and Instruction (Chicago: The University of Chicago Press, 1963), p. 4.

[3] Doll, op. cit., p. 100.

student the scientific attitudes," it should say "to learn scientific attitudes."

> Given such a statement, it is then possible to infer the kinds of activities which the instructor might carry on in an effort to attain the objectives--that is, in an effort to bring about the desired changes in the student.[1]

2. Is the desired behavior observable? Can its attainment be evaluated in some way?

   This criterion is derived from the belief that any educational outcome should be evaluated. If a certain behavior cannot be observed or evaluated, there is no way for one to know whether it is attained.

3. Are the objectives stated clearly and specifically enough so that there is no doubt as to the kind of behavior expected? Are the terms defined operationally?

   Taba expressed a similar idea.

> Too often statements of educational objectives lack the concreteness and clarity that are needed if they are to serve as a guide for making decisions about the curriculum or about evaluation. They are stated in terms too general or too vague to be translated into educational practice. Such statements as "to develop a method of inquiry," a "mind that can cope with complexities of modern life," "appreciation of the beautiful," "loyalty to truth," or "a knowledge and attitude basic to being a responsible citizen" are too broad, too vague, or both.[2]

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[1] Tyler, op. cit., p. 28. [2] Taba, op. cit., p. 201.

4. Are the objectives attainable and feasible in the time and facilities allocated to the school?

Some objectives fail to recognize the age level of the student. They might, for example, require the student to master some instrumental skills which are too difficult for his muscular development and coordination. They might deal with concepts which cannot be conceptualized easily in the learner's age level.

> The old school of thought which attempted to teach children to be utterly quiet while they were in school was imposing an educational objective impossible of attainment.[1]

Psychology of learning provides one with some ideas as to the feasibility and attainability of certain objectives. More research is needed, though, in areas such as concept formation, readiness, and attitude change through learning.

5. Are the objectives desirable in terms of a set of values derived from the values of the culture?

What are the major values of the U.A.R. culture? These values and beliefs are stated in the national charter approved by an elected national assembly as a guide for national objectives and beliefs.

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[1]Tyler, op. cit., p. 25.

Emerging Social Beliefs and Values Related to the Objectives

The U.A.R. people are attempting to rebuild their country on the foundation of some principles derived from the history of the country and its needs. This was expressed in the national charter. Some of the principles stated are the following:

a. A belief in democracy

> Democracy means the assertion of sovereignty of the people, the placing of all authority in their hands and the consecration of all powers to serve their ends.[1]

b. A belief in socialism

Formerly, approximately one-half of a per cent of the population owned fifty per cent of the national wealth. Citizens of the U.A.R. believed that redistribution of national wealth would be the only means for a better life for the individual and the nation.

The charter defines socialism as:

> The setting up of a society on a basis of sufficiency and justice, of work and equal opportunity for all, and of production and services. . . .[2]

> Socialism is the way to social freedom. Social freedom cannot be realized except

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[1] United Arab Republic, Information Department, Cairo, The Charter, 1962, p. 36.

[2] Ibid.

> through an equal opportunity for every citizen to obtain a fair share of the national wealth.[1]

c. A belief in Arab unity

> The United Arab Republic, firmly convinced that she is an integral part of the Arab Nation, must propagate her call for unity and the principles it embodies. . . .[2]

d. A belief in non-alignment and positive neutrality

The U.A.R. stands for neutrality between opposing camps and resists attempts to launch her in the conflict between the two blocs.

6. Are the objectives broad enough to encompass all types of outcomes needed to be attained by the school?

Schools usually focus on objectives dealing with mastery of facts, principles, and concepts. Less tangible objectives such as scientific thinking and scientific attitudes are often neglected. Objectives should be adequate and comprehensive in view of the educational philosophy of the school system.

7. Are the objectives developmental? Do they represent roads to travel rather than terminal points?[3]

Objectives dealing with the scientific method of thinking and scientific attitudes require a cumulative

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[1]Ibid., p. 49. [2]Ibid., p. 90.

[3]Taba, op. cit., p. 203.

development over a period of time. This suggests that different courses should contribute cumulatively to the growth and development of such a skill. Each course might aim to develop a constituent of such a skill such as the formulation of hypotheses, the collection of data, reaching conclusions, or the use of controlled experiments.

8. Are the objectives based on three major sources of data: (a) society, (b) the learner's human growth and development, and the learning process, and (c) the nature and structure of the discipline?

While analyzing these three sources in the third chapter, it was concluded that the following ought to be the objectives of teaching science in the Egyptian schools. The eight criteria mentioned in this chapter were considered in stating the following objectives.

A Suggested List of Objectives for Teaching Science in the Preparatory and Secondary Schools in the U.A.R.

First: Objectives concerned with functional facts, principles, and concepts

a. To learn some fundamental principles, concepts, and conceptual schemes which could help the student to understand himself, his environment, and the universe.

b. To learn about social problems and the role of science in dealing with them.

c. To learn about the human body and physiological changes which occur in different periods of growth and development.

Second: Objectives concerned with scientific thinking skills. To learn and practice the following skills:

a. To state the problems precisely.

b. To observe significant and relevant incidents.

c. To state hypotheses.

d. To identify necessary data to solve a problem.

e. To test hypotheses.

f. To reformulate the problem, the hypotheses, and the conclusions in view of new data.

g. To draw a conclusion.

h. To assimilate learned information in one's own knowledge and act accordingly.

i. To control factors.

Third: Objectives concerned with attitudes

a. To learn to accept change as a universal phenomenon and to cope with it when it occurs.

b. To develop the attitude of adventuring, trying out, experimenting, and creating.

c. To develop one's need to achieve.

d. To develop respect for manual work and to consider it as a possible career.

e. To develop a cooperative attitude toward the group and the community.

f. To develop the following scientific attitudes:

1) Belief in cause and effect and rejecting superstitions

2) Questioning, testing, and experimenting

3) Willingness to change an opinion or conclusion because of new evidence

4) Unwillingness to base a conclusion on one or a few observations.

Fourth: Objectives concerned with instrumental skills. To learn the following instrumental skills:

a. Reading science content with understanding.

b. Performing fundamental operations with reasonable accuracy.

c. Measuring precisely and accurately.

d. Identifying various processes of laboratory equipment, recognizing the function of each, and manipulating them scientifically.

e. Interpreting and developing maps, graphs, charts, and tables.

f. Writing a concise report.

Fifth: Objectives concerned with interests and appreciations

a. To develop interest in science.

b. To appreciate the scientific way of thinking as a unique approach to inquiry.

The author deems it necessary to define some of the terms which have been used in the previous list of objectives.

Concept:

> A concept is a reduction, in a sense, of events to a recognizable configuration.[1]

Conceptual scheme:

> A conceptual scheme is a relationship between a number of concepts.[2]

Scientific method of thinking:

> Includes all the operations, procedures, devices, and types of processes similar to those by which scientists arrive at conceptual schemes.[3]

Criteria for Selection of Content and Learning Experiences

The second process in curriculum development is the selection of content and learning experiences. The writer prefers to distinguish between the two terms "content" and "learning experience" to avoid misunderstanding. The term "content" refers to fundamental facts, principles, and concepts. The term "learning experience" is used to refer to the interaction between learners and their environment which creates behavioral changes in the learners.[4] Thus, learning experiences might include content as one of their

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[1]Paul F. Brandwein, *et al.*, *Teaching High School Science: A Book of Methods* (New York: Harcourt, Brace and World, Inc., 1958), p. 110.

[2]*Ibid.*, p. 111. [3]*Ibid.*

[4]Doll, *op. cit.*, p. 110.

constituents. It has been indicated in the third chapter that subject matter content should be selected jointly by specialists and educators on the national level. The following are some criteria to guide content selection.

1. Is the content valid and significant?

   A valid significant content focuses on the fundamentals of the discipline and reflects the contemporary scientific knowledge. The rationale behind teaching the fundamentals of the discipline was developed in the third chapter.

2. Is the content relevant to social and personal problems and needs?

   If the curriculum is to be a useful prescription for learning, its content and the outcomes it pursues need to be in tune with the social and cultural realities of the times.[1] For example, in an underdeveloped country such as the U.A.R. content in science should deal with problems of energy, natural resources, and conservation. A curriculum which fails to deal with social and personal life is not consistent with social realities.

3. Could the content be assimilated into learning experiences which serve the wide range of objectives?

   Subject matter content which, for example, is merely informational in character, will fail to fit

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[1]Taba, op. cit., p. 272.

into a program which aims at teaching methods of thinking, skills, and attitudes.

The following are some criteria to guide the selection of learning experiences.

1. Is the learning experience valid?

   Validity of the learning experience refers to the degree to which the students learn what is intended to be learned. For example, a learning experience aiming at the student's learning the use of graphs is valid as far as it improves the performance of students in using graphs.

2. Does the learning experience allow the students to practice the desired behavior?

   That is to say, if one of the objectives is to develop skill in problem solving, this cannot be attained unless the learning experiences give the student ample opportunity to solve problems.[1]

3. Is the learning experience satisfying to the student?

   The information known about the pattern of growth and development of the learners, their interests, and their needs will help in judging whether or not an experience will be satisfying.

4. Does the learning experience build upon the previous experiences of the learners? Is it within

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[1]Tyler, op. cit., p. 42.

the learner's ranges of capability?

5. Are learning experiences as varied as the objectives?

Criteria for Effective Organization of Learning Experiences

The organization of learning experiences is the process through which the interrelationships between the learning experiences in different grades are planned. The process of planning these relationships moves in two directions: a vertical direction through which, for example, the relationships between learning experiences in ninth and tenth grades are planned; and, a horizontal direction through which the relationships between learning experiences in one grade are planned.

It is clear that change in human behavior cannot be produced simultaneously by a single learning experience. It is developmental in nature. As Tyler states:

> In some respects educational experiences produce their effects in the way water dripping upon a stone wears it away. In a day or a week or a month there is no appreciable change in the stone, but over a period of years definite erosion is noted. Correspondingly, by the cumulation of educational experiences profound changes are brought about in the learner.[1]

Thus, the final aim of organization of learning experience is to produce cumulative learning. The following are some criteria for effective organization of learning experiences.

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[1] *Ibid.*, p. 54.

1. Does the organization provide for continuity?

   Tyler defined continuity as the vertical reiteration of major curriculum elements.[1] For example, a chance to practice a skill such as the use of controlled experiments might be provided for continually in different grades.

2. Does the organization provide for early learning and late learning?

   individual difference + learner!

   (Teachers with more years of teaching exp.

   It was found in the review of literature on learning that learning occurs in two stages: early learning, which is slow and involves the acquisition of basic discriminations; and, late learning, which builds rapidly upon the foundation of early learning. An effective organization of learning experiences should utilize this research finding. For example, a concept such as universal gravity or relativity should be introduced twice in the science curricula. This could be done, for instance, by introducing the concept in an early grade and repeating it in more detail in a later grade.

3. Does the organization of learning experiences provide for sequence?

   An organization provides for a good sequence if successive experiences build upon the preceding

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[1] Ibid., p. 55.

ones and yet increase the student's mastery of the learned skill or behavior.

Criteria for a Program of Evaluation

The criteria developed so far in this chapter could help in the first three steps of curriculum development. These steps are stating the objectives, selection of learning experiences, and organization of learning experiences. The process through which the success of the learning experiences in achieving the objectives is tested is the evaluation process. Tyler defines the evaluation process as a process for finding out how far the learning experiences as developed and organized are actually producing the desired results.[1]

Many teachers in the U.A.R. think of evaluation as synonymous with the giving of paper and pencil tests. Since evaluation is aiming at getting evidence about behavior changes in the learners, any valid method of obtaining this evidence is a desirable method of evaluation. These methods could be paper and pencil tests, observation, interview, tape recorder techniques, attitude scales, interest inventories, sociograms, questionnaires, performance tests, anecdotal records, or rating scales.

A comprehensive evaluation program should be included in the planning when objectives and learning

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[1] *Ibid.*

experiences are selected. The planning of such a program could include the following steps:

1. Identification of the specific objectives of the course. Behavioral changes sought could be inferred from this list of objectives.
2. Deciding which specific topics or learning experiences are aimed at achieving each objective.
3. Selection or construction of suitable device(s) to evaluate each behavior. Two identical forms of the device might be necessary to appraise the student's performance before and after the learning occurs.

The data collected in these three steps could be condensed in tables. This will help teachers to relate objectives, learning experiences, and evaluation devices. Table 5 is an illustration of such a table for a unit about energy.

Data collected from the process of evaluation are helpful in developing hypotheses regarding needed change.

The following are some criteria for a comprehensive program of evaluation.

1. Is the evaluation program consistent with the stated objectives?

   Evaluation should be based on what is expressed as significant achievement in the objectives. If the learning program emphasizes scientific thinking, scientific attitudes, and instrumental skills,

TABLE 5

AN ILLUSTRATION OF USING TABLES TO RELATE OBJECTIVES, LEARNING EXPERIENCES, AND EVALUATION INSTRUMENTS

Objectives	Learning experiences and content	Evaluation instrument
1. To learn about social problems and the role of science in dealing with them	Natural resources in the U.A.R.--Electricity from Aswan Dam--Energy from radioactive materials	Discussions Paper and pencil tests
2. To learn how to use controlled experiments	Traveling of light, sound, and heat energies in different media	Performance in problem solving laboratory experiments Observation
3. To believe in the relationships of cause and effect	How were petroleum, charcoal, and natural gases formed	Discussion Attitude scales
4. To learn to measure precisely	Units of measuring electricity, heat, atomic, and sound energies	Performance tests Observation in laboratory Grading of laboratory work
5. To develop interest in science	How to produce energy from chemicals	Participation in science clubs and fairs Interest inventories

The objectives stated in this table are derived from the list of objectives suggested by the writer for teaching science in the Egyptian preparatory and secondary schools.

the evaluation program should not be limited to achievement tests. It should use a variety of instruments and techniques of evaluation.

2. Does the evaluation program include a comparison between the student's performance before and after the learning situations?

3. Is the evaluation process continuous?

Evaluation should not be limited to an after learning test. It should be carried on continually with the progress of the learning programs. This is especially significant if techniques such as observation, anecdotal records, and performance tests are used for evaluation.

4. Are the instruments used for evaluation reliable and valid?

Reliability refers to stability or consistency. Test reliability is the consistency of scores obtained by the same persons when retested with the identical test or with an equivalent form of the test.[1] Validity refers to the degree to which the instrument actually measures what it purports to measure.[2]

5. Does the evaluation program help to initiate

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[1]Anne Anastasi, <u>Psychological Testing</u> (New York: The Macmillan Company, 1961), p. 28.

[2]*Ibid.*, p. 29.

further steps in the development of curricula?

A successful evaluation program wields further attempts to improve learning experiences and, in general, the educational program.

Summary of Processes Suggested for the Development of the Science Curriculum in the U.A.R. Preparatory and Secondary Schools

This part of the chapter is devoted to a summary of the processes for the development of the science curricula suggested in the third chapter. The following are the assumptions underlying the suggested model:

1. Curricula are planned at the national level in Cairo. The planning department of the Preparatory and Secondary Education in the Ministry of Education initiates and plans for the development of the curricula.
2. There is a trend toward guaranteeing teachers in local school systems more flexibility for adjusting curricula to the school circumstances. This trend is recognized in the choices of textbooks given to some school systems. The teacher is allowed to change sequences to fit the nature of life in different seasons.

The following are the suggested processes for science curriculum development:

1. A committee of educators, sociologists, and parents should be assigned the task of examining the U.A.R.

culture, national problems, social values and beliefs. Implications of this study to the science curriculum could be stated in the form of desirable behavioral objectives. An example of what could be achieved in such a step is indicated in the examination of social problems in the third chapter.

2. A committee of educators and psychologists should examine findings of research on learning and the nature of the Egyptian adolescents. Implications of this examination could provide helpful information for the planning of science curriculum. An example of this process is indicated in the psychological foundations in the third chapter.

3. A committee of scientists and educators should examine the structure of science to identify the fundamentals of the discipline. An examination of similar endeavors in more advanced countries might suggest some desirable directions. Studies such as the PSSC, the BSCS, and the CBA might represent a starting point.

4. Representative members of the previous three committees could form the major curriculum committee. This committee could decide the objectives of teaching science in view of some selected criteria. The section on "Criteria for Formulating Objectives" of this chapter includes a list of criteria for

selecting objectives. The list of objectives suggested might help in this endeavor. The criteria for the selection of content and learning experiences provided in the second section of this chapter and the criteria for an effective organization of learning experiences in the third section could be helpful for curriculum committees in the U.A.R. This committee should supervise the development of textbooks, teacher's guides, and similar instructional materials. The evaluation program should not be overlooked. Characteristics of a comprehensive program of evaluation are indicated in the fourth section of Chapter IV.

5. This selected curriculum should be tried in some sample schools for a year before its implementation in the whole country. A fair sample should be insured by selecting schools representing different environments in the country.

6. The new curriculum could be generalized to the school system as a whole if it proves suitable according to the evaluation process.

Figure 4 is an outline of the proposed model.

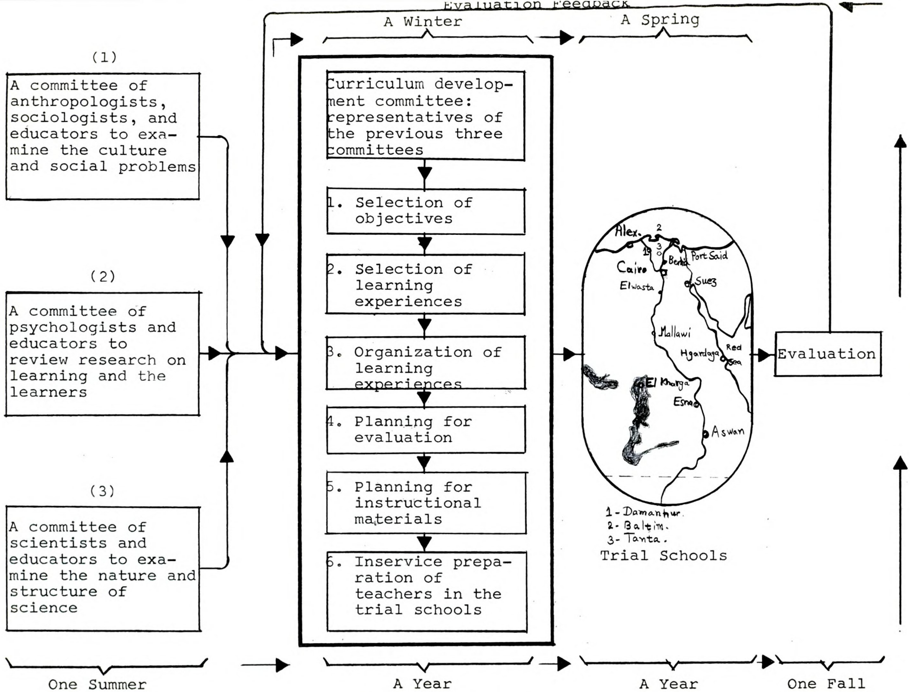

Fig. 4.--The Model

CHAPTER V

SCREENING THE CURRENT SCIENCE CURRICULUM IN THE U.A.R. PREPARATORY AND SECONDARY SCHOOLS USING THE DEVELOPED CRITERIA

The fourth chapter has been devoted to developing criteria to guide decision making in curriculum development. The applicability of these criteria will be demonstrated in this chapter in screening the current science curriculum in the U.A.R. preparatory and secondary schools. The reader is referred to the fourth chapter for a review of this set of criteria.

In the preparatory school, science is offered in the form of general science. Four units are taught in the seventh grade: (1) water in our lives, (2) air in our lives, (3) housing in our lives, and (4) a unit on first aid. The units dealt with in the eighth grade are: (1) machines in our lives, (2) transportation in our lives, (3) nutrition in our lives, and (4) fuel in our lives. In the ninth grade, science curriculum deals with two major social problems: (1) the role of science in the national economic growth, and (2) the role of science in improving health conditions. A unit about the universe is also included.

In the secondary school, science is taught in the form of separate courses in physics, chemistry, and natural history. Physics is taught in the tenth, eleventh, and twelfth grades for two, three, and four hours a week, respectively. Chemistry and natural history are taught for two, three, and three hours each in the respective grades. The reader is referred to Appendix I which presents an outline of the physics syllabus as an example of science content in secondary schools.

Screening the Objectives

As stated in Chapter III the objectives of teaching science in the preparatory schools are:

> (1) to develop in the student the ability to observe scientifically and precisely and to initiate their appreciation to this scientific age, (2) to provide him with information which would help him understand natural phenomena, control the environment, and benefit from it, (3) to illustrate the role of science in economic growth, (4) to help the students understand the physiology of the human body and habits of good hygiene, (5) to illustrate the role of science in introducing favorable health conditions in the nation, (6) to develop the student's ability to use the scientific method of thinking, (7) to provide the students with some experiences in using scientific attitudes, (8) to allow them to select a scientific hobby.[1]

Using the criteria for selecting objectives developed in the fourth chapter in evaluating this list, one discovers that:

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[1]Hanna, op. cit., pp. 3-4.

A. Most of these objectives are stated from the standpoint of the teacher's action, such as "to develop in the student . . . ," "to provide them . . . ," and "to illustrate. . . ." The student appears to be viewed as a passive recipient of something emitted by the teacher. Objectives should be stated from the standpoint of the pupil's behavior rather than of the teacher's behavior.

B. Some other objectives are too broad to the extent that it is not easy to infer the kind of behavior expected. As an example, it is difficult to define the behavior which the students should exhibit when they "control the environment and benefit from it," as it is stated in the second objective.

C. This set of objectives failed to encompass objectives concerned with instrumental skills.

It is very important to restate this set of objectives in view of the suggested criteria. This would enable the objectives to be instrumental in decision making in curriculum development. The list of objectives offered in the fourth chapter is suggested as the objectives for teaching science in preparatory and secondary schools of the U.A.R.

Screening the Content and Learning Experiences

A. Preparatory school science

1. The subject matter content deals with some social and individual problems and needs.
2. The content could be easily assimilated into classroom learning experiences. It is very rich with activity oriented learning situations.
3. The planned learning experiences, if provided properly, could allow the students to practice the desired behaviors. This is particularly true in units on first aid, air, and nutrition.
4. Some units merely repeat some learning experiences of the elementary school curriculum. This is most obvious in the units of water, air, and housing in the seventh grade. This statement is supported by the findings of a curriculum committee appointed by the vice-minister of education.[1]
5. Content and learning experiences of the ninth grade have been found very unsatisfactory. An encyclopedic collection of highly difficult and unrelated facts are presented to the student. The content is considered very sophisticated compared to the previous experiences of the

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[1] Ibid., p. 10.

students.[1] The areas dealt with in this grade are non-experimental in nature which encourages rote learning. The mere retention of facts impedes the fulfillment of objectives aimed at behavioral change.

B. Secondary school science

Examining Appendix I which summarizes the syllabus of physics in the secondary schools, one discovers that it is stated merely in terms of subject matter content. No learning experiences are suggested. Thus, this syllabus will be screened only in view of the criteria of selecting and organizing content. When this screening is carried on, one discovers that:

1. Subject matter content, especially in physics, does not reflect the contemporary scientific knowledge. Some examples of this are the following:
   a. The corpuscular nature of light is not covered.
   b. The relationship between matter and energy is not emphasized.
   c. The universal law of gravitation is overlooked.

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[1] *Ibid.*

d. Electricity, heat, light, chemical and atomic energies are treated as separate entities. The curriculum fails to illustrate the relationship between them as forms of energy.

2. The rationale behind including some topics in the content is not clear. Similar topics are irrelevant to social problems and students' needs, and do not represent a fundamental area in the discipline. The following are some examples:

   a. Real and apparent coefficients of a liquid and their determination.

   b. Determination of the frequency of a note by Savart's wheel and the siren.

   c. The manufacturing of soap, leather tanning, vinegar, dyes, and matches.

   d. Phosphorus preparation and properties.

3. The subject matter content fails to provide for a good sequence. For example, the content of physics in the tenth grade deals with five separate areas: sound, light, magnetism, electricity, and heat. The same areas are treated again in grades eleven and twelve. A better planning for sequence and continuity could be achieved by considering heat,

electricity, light, sound, magnetism, chemical, and nuclear energies as different forms of energy. Ninth grade physics, for example, could be devoted to the learning of energy production and its transformation. The transmission of different forms of energies and ways they travel could be learned in the tenth grade. In the following grades, measurement of different forms of energy and their utilization in modern life could be learned. Through such an organization of content, students might sense more meaning, sequence, and continuity of learning experiences. The student might be more capable of relating topics in the same course and different courses to each other.

Screening the Evaluation Program

As was indicated in the fourth chapter, evaluation is almost viewed as synonymous with testing. Most of the emphasis is put on achievement of the student in the final test or on a national examination. If one examines such a program of evaluation using the criteria developed in the fourth chapter, one concludes the following:

A. The evaluation program is not consistent with the stated objectives.

It does not attempt to evaluate some behavioral outcomes such as scientific thinking, scientific

attitudes, and instrumental skills.

B. The evaluation program does not include a comparison between the student's performances before and after the learning situations.

C. The reliability and validity of the examinations were not tested or determined.

D. The evaluation program focusing on the student's achievement will naturally fail to be instrumental in the improvement of the educational program. The effectiveness of the instrumental materials is rarely examined. The efficiency of teachers is sometimes measured through their students' achievement or performance.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This study attempted to build up a model for the development of science curriculum in the preparatory and secondary schools in the U.A.R. The model suggested an approach to curriculum development focusing upon developing a rationale for decision making. Such a rationale makes curriculum development rational and scientific rather than a rule-of-thumb procedure. The rationale has drawn upon analyses of society and culture, studies of the learners and the learning process, and analyses of the nature of the discipline.

The following social problems have been found the most significant: (1) a low standard of living, (2) a high rate of population increase, (3) unemployment and underemployment, and (4) illiteracy. Some emerging values and beliefs have been considered as highly related to decision making in curriculum. Democracy, socialism, Arab unity, and non-alignment form the cornerstones of current social beliefs and values.

Research findings have been reviewed in areas of reward and punishment, transfer of learning, motivation, and development and concept formation. Studies about the

learners in the preparatory and secondary schools have been outlined.

The last area which has been examined is the nature and structure of science (the discipline). A definition of the term "structure" has been provided. Review of research on science education has been considered.

The examination of the three areas of society, the nature of learning and the learners, and the nature and structure of science, has yielded the following three implications to curriculum development:

A. Desirable learning experiences

1. Learning about natural resources and how to increase them--conservation
2. Learning about forms of energy and their transformations
3. Learning about ways science can serve economic growth
4. Learning about reproduction in human beings and ways of birth control
5. Learning some instrumental skills which might help in manual careers
6. Learning about micro-organisms--diseases and how to avoid them
7. Learning about physical and mental growth of the human being and physiological changes in adolescents--desirable nutrition and hygiene habits

B. Desirable behaviors, attitudes, and values

1. Accepting change as a universal phenomenon, and readiness to cope with it as it occurs
2. Developing an attitude of adventuring, experimenting, and desire to try out
3. Respecting manual work
4. Developing the "need for achievement"
5. Believing in the relationship of cause and effect
6. Learning to cooperate with the group and to accept responsibility

C. A desirable approach to curriculum development

It has been indicated that scientific curriculum development needs to draw upon analyses of society and culture, studies of the learner and the learning process, and analysis of the nature of knowledge. This principle has worked as the foundation of the model suggested at the end of Chapter IV. Figure 4 on page 109 outlines the suggested procedures for science curriculum development. It also indicates the time allocated to each step or procedure. This model on page 109 recommends to the Ministry of Education an approach to the science curriculum development.

The following is a summary of criteria to guide decision making in curriculum development. These

have been discussed in detail in Chapter IV.

1. Criteria for formulating objectives

   a. Are the objectives clearly defined in terms of behavioral change in the student?

   b. Is the desired behavior observable? Can its attainment be evaluated in some way?

   c. Are the objectives stated clearly and specifically enough so that there is no doubt as to the kind of behavior expected? Are the terms defined operationally?

   d. Are the objectives attainable and feasible in the time and facilities allocated to the school?

   e. Are the objectives desirable in terms of a set of values derived from the values of the culture?

   f. Are the objectives broad enough to encompass all types of outcomes needed to be attained by the school?

   g. Are the objectives developmental? Do they represent roads to travel rather than terminal points?

   h. Are the objectives based on three major sources of data: (1) society, (2) the learner's human growth and development, and the learning process, and (3) the nature and

structure of the discipline?

2. Criteria for selection of content and learning experiences
    a. Is the content valid and significant?
    b. Is the content relevant to social and personal problems and needs?
    c. Could the content be assimilated into learning experiences which serve the wide range of objectives?
    d. Is the learning experience valid?
    e. Does the learning experience allow the students to practice the desired behavior?
    f. Is the learning experience satisfying to the student?
    g. Does the learning experience build upon the previous experiences of the learners? Is it within the learner's ranges of capability?
3. Criteria for effective organization of learning experiences
    a. Does the organization provide for continuity?
    b. Does the organization provide for early learning and late learning?
    c. Does the organization of learning experiences provide for sequence?
4. Criteria for a comprehensive program of evaluation
    a. Is the evaluation program consistent with the

stated objectives?

b. Does the evaluation program include a comparison between the student's performance before and after the learning situations?

c. Is the evaluation process continuous?

d. Are the instruments used for evaluation reliable and valid?

e. Does the evaluation program help to initiate further steps in the development of curricula?

A list of objectives for teaching science in the U.A.R. preparatory and secondary schools has been suggested on page 94.

The applicability of the previous set of criteria in guiding decision making in curriculum development has been demonstrated in Chapter V. The reader is referred to that chapter for more recommendations. The most important of these recommendations are the following:

1. To reformulate objectives in view of a selected set of criteria
2. To enrich learning experiences in the seventh and eighth grades in such a way that duplication of learning experiences in the elementary school could be avoided
3. To consider a radical change in the content and learning experiences in the ninth grade
4. To give more attention to some areas which reflect

the current scientific knowledge such as the corpuscular nature of light, the relationship between matter and energy, the universal law of gravitation. . .

5. Better planning for continuity and sequency of content and learning experiences is needed. Related units could be followed through grades nine, ten, eleven, and twelve. For example, ninth grade physical science could focus upon production of forms of energy. Following grades could focus on one or more of the following:
   a. Transformation of forms of energy to each other
   b. Ways of traveling of different forms of energy and their transmission
   c. Measurement of different forms of energy, their control, and their utilization in life.

   An example of such a plan is presented in the author's book, Energy.[1] This book was used as a textbook for an experimental study conducted by the author in 1962. The study was carried on to test the results of substituting the separate courses of chemistry and physics in the tenth grade by a correlated course dealing with energy. The emphasis was on learning general concepts and principles

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[1]Gamal Elashhab, Energy (Cairo: Nokrashy Experimental Secondary School Printing Office, 1962).

rather than facts. An inquiry approach was used in the laboratory work.

Recommendations for Further Studies

Curriculum improvement is a continuous process. No single attempt or study is capable of answering all the raised questions. It is hoped that the current study could initiate some follow-up studies about science teaching in the U.A.R. The following are some questions which further research could answer:

1. What are the most effective methods of bringing about curricular change? How does innovation diffuse in the U.A.R. schools?
2. How could teacher preparation and inservice education be established in such a way that continuous examination of curricula is initiated? How to decrease the teacher's resistances to curriculum change?
3. How is the teacher's behavior and personality related to behavioral changes in the students?
4. How to design and conduct research on methods of teaching in terms of empirically established experiences?
5. How could the problem of content placement in different grades be solved?
6. What are the most effective techniques and instruments for evaluating the desirable behavioral outcomes?

Once Gibran, a great philosopher wrote: "Say not, I have found the truth, but rather, I have found a truth." The author of this study is not of the belief that he has proposed the only way, but rather, a way of bringing about curricular change. Hopefully this study will initiate further studies in the development of science curricula in the U.A.R.

APPENDIX I

THE SYLLABUS OF PHYSICS FOR TENTH, ELEVENTH, AND TWELFTH GRADES

Tenth Grade

I. Sound

  A. Sound is caused by vibration

  B. Intensity and pitch

  C. Musical instruments

  D. Velocity of sound in air and its determination--reflection of sound

  E. Recording

II. Light

  A. Light and life

  B. Light travels in straight lines--formation of images and shadows

  C. Reflection in plane mirrors

  D. Refraction of light

  E. Lenses

  F. Optical instruments

III. Magnetism and electricity

  A. Repulsion and attraction of poles--magnetic fields

  B. Electrical cell

  C. Detection of electrical current

D. Ways of connecting cells

E. Magnetic and thermal effect of electrical current

F. Electric potential--Ohm's Law

IV. Heat

A. Apparent and real expansion of liquids

B. Humidity--meteorology

<u>Eleventh Grade</u>

I. Properties of matter

A. Properties of stationary liquids--pressure--pascal principle and hydraulic press

B. Water wheels and turbines

C. Archimedes' principle--floating bodies--hydrometers

D. States of matter and their general properties

II. Heat

A. Laws of solids expansion

B. Laws of liquids expansion

C. Effect of heat on the volume and pressure of gases

D. Measurement of quantity of heat--specific heat--latent heat

E. Heat is a form of energy

F. Steam engines--internal combustion engines--thermal efficiency of engine

III. Light

A. Photometric measurements

B. Reflection in spherical surface

C. Refraction of light

D. Deviation in a prism

E. Lenses--their function and general law--eye--eye defects and their correction--optical apparatuses

F. Dispersion of light--spectrum and spectrometer--ultraviolet and infrared rays

Twelfth Grade

I. Sound

A. Longitudinal and transverse waves--standing waves

B. Relationship between wave length, frequency and velocity of wave propagation

C. Savart's wheel and determination of frequency

D. The laws of transverse vibrations of strings

E. Resonance

F. Harmonic notes--the musical scale

II. Magnetism

A. Law of inverse square--pole unit

B. Magnetic field--its unit

C. Tangent law--the magnetometer

III. Static electricity

A. Electrification by rubbing

B. Electric field--electric induction--the electroscope--unit of potential

C. Electric capacity--unit of capacity

IV. Dynamic electricity

A. The magnetic field at the center of a circular coil--absolute unit of current--the practical unit

B. Units of electric quantity--units of current--units of resistance

C. The chemical effect of current--Faraday's laws--types of electrical cells

D. The thermal effect of current

E. Induced currents

F. Electric discharge in rarified gases

G. The electromagnetic waves--radio--radar--television

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