MODERN METHODS AND MATERIALS FOR THE ENRICHMENT AND THE IMPROVEMENT OF THE CHEMISTRY CURRICULUM IN THE SECONDARY SCHOOLS OF IRAQ

by

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A THESIS

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I N T R O D U C T I O N

A. Importance of Teaching Chemistry

The chemist and other scientists have played their part in bringing about vast changes in our way of life. There is scarcely any phase of modern life that the chemist has not changed. Among his many achievements, it can be recorded that he has transformed coal tar into dyes, cotton into explosives, and wood into paper. He has synthesized dyes into an infinite variety of shades and has produced medicines to prevent or cure diseases, drugs and anasthetics to alleviate pain, fertilizers to increase the crops and various kinds of alloys to meet the needs of modern constructions in industry. In fact, our environment is greatly influenced by the work of the chemist. The clothing we wear; the fuel we use; many facilities and commonplace processes at home such as cleaning, removing of stains, refrigeration and baking; consumers' products; and industrial processes which produce our necessities, all are based on chemical information, and chemistry actually permeates every phase of our life.

An understanding of chemistry is essential in many professions. If one expects to become a physician, a dentist, a nurse, a pharmacist, an engineer, or a geologist, chemistry is an essential subject. For many industrial occupations, knowledge of chemistry is a necessity. It is also valuable for the ordinary man since it plays an important role in daily life.

Chemistry, then, is important both for those who plan to specialize in some profession related to chemistry and for those who do not. Secondary school chemistry should serve a two-fold purpose in order to keep pace with the new age in education and the new age in science. The first is to contribute generously to the general education of all students. The second is to help lay the foundation needed by some of the students for later specialization in science.

B. Purpose of the Thesis

Although chemistry permeates every phase of our life, it is nevertheless taught in the secondary schools of Iraq as though it were "ancient history" — set apart from actual life, and from students' problems, needs, and experiences. It is not taught for its utilitarian value, and actually very little is achieved. Critical evaluation of the chemistry curriculum in the secondary schools of Iraq reveals many lacks, deficiencies, and inadequacies in objectives, methods, materials, and content.

This thesis is an attempt to point out the defects of chemistry teaching in the secondary schools of Iraq and to present in a straightforward way some of the more recent findings and practices in education as they apply to chemistry teaching in Iraq. It deals with modern methods, materials and content, which can improve and enrich the chemistry curriculum in the secondary schools of Iraq. It also charts a path which may be followed in order to produce genuine enrichment and improvement of the chemistry curriculum.

The writer has tried to avoid presenting educational theories in detail. This is not a collection of high-sounding educational theories. Rather, it contains suggestions drawn from the thinking and practice of many teachers and experts in the field of science education, and from the writer's own thinking and experience in teaching chemistry in the secondary schools of Iraq.

The writer's interest in this topic is the direct result of his dissatisfaction with the status quo of chemistry teaching in Iraq. Most of the problems which this thesis attempts to solve have been met by the writer during his actual teaching of secondary school chemistry.

C. Procedure

The sequence of steps in the procedure was as follows:

1. A study was made of the actual situation of chemistry teaching in Iraq — its objectives, methods, materials, content, and the practices of its teachers. Much basic information for this study was derived from a critical analysis of the recommendations and syllabi of the Ministry of Education, from the writer's own experience in teaching secondary school chemistry and from the ideas, criticisms, and recommendations of a number of chemistry teachers in Iraq with whom the writer has corresponded.

2. For the purpose of securing a good foundation for

the study, all available literature relating to science instruction in secondary schools was examined. Bibliographies of past and present publications were searched, and those which were pertinent to the problem were studied carefully. Many articles listed in the Educational Index under high school chemistry and high school science (especially those found in the Journal of Chemical Education) were read and utilized. Modern texts in high school chemistry were also examined for content, objectives, classroom procedures, and teaching materials. In addition, many books dealing with ways of improving the curriculum were examined, and applicable items were adapted to Iraq's present situation.

For a complete list of pertinent materials see the bibliography.

D. <u>Organization</u>

The thesis is divided into four parts. Part I deals with the present situation of chemistry teaching in Iraq. It attempts to analyze and point out the defects of chemistry teaching in Iraq. Part II discusses the modern trends in objectives and practices of chemistry teaching. Part III is the central theme of the thesis. It suggests methods, materials, and content which are most appropriate for Iraq in its present stage of development and which can enrich and improve the chemistry curriculum in the secondary schools. Part IV suggests ways in which the chemistry teachers, the Ministry of Education, the teachers' college, the inspector and the curriculum worker may help bridge the gap that at present exists between the actual situation of chemistry teaching in Iraq, and the modern educational theory and practice as regards methods, materials, and content of the chemistry curriculum.

Part I includes the introduction which gives a brief indication of the importance of teaching chemistry, the purpose and scope of this study, the procedure followed in doing this study, and the organization followed in writing the thesis. Chapter I deals with the background of education in Iraq. It shows the nature of the educational system, the educational ladder, the examinations, the curriculums and the textbooks. Chapter II deals with the objectives and practices of the secondary school in Iraq. It criticises the objectives and the practices of both the intermediate and the preparatory unit, and gives general comments on the objectives of the secondary school. The chapter ends by pointing out the factors compelling change in the secondary school of Iraq. Both chapter I and II are designed to show the setting in which the chemistry teacher has to operate. Chapter III discusses the objectives of chemistry teaching in the intermediate and preparatory units of the secondary school as the Ministry of Education presumably sees them. Chapter IV describes and criticises, first, the methods of chemistry teaching in the intermediate and preparatory units of the secondary school as inferred from the official syllabi, and then it makes observations on the methods of chemistry teaching actually in use in the secondary school of Iraq. Chapter V deals with the chemistry curriculum in the secondary school of Iraq. The content of the curriculum is given first, then, both content and organization are analysed and criticised.

Part II contains the following chapters:

Chpater VI deals with modern objectives of the secondary school as compared with the objectives of the secondary school in Iraq. Chapter VII deals with modern objectives of chemistry teaching as compared with objectives of chemistry teaching in Iraq. Chapter VIII explains those aspects of methods and practices which help to implement the modern objectives of chemistry teaching. It discusses the meaning of teaching, the role of experience in learning, the teaching of facts and concepts, the teaching of laws, and the teaching for improvement of thinking. The chapter is concluded by giving the psychological and educational considerations which support the suggestions proposed in the chapter.

Part III contains the following:

An introduction to chapter IX and X is made to explain the role of the teacher in the learning process, the proven contributions of audio-visual methods and materials, and how to utilize them properly. Chapter IX describes how to use the laboratory method, the demonstration method, individual and group projects, field trips and co-curricular activities that can enrich and vitalize students' experiences. Chapter X illustrates how audio-visual materials can be used to improve students' learning. It explains how to use the microprojector, the motion picture, television, models, exhibits, museums, science fairs, the stereoscope, filmstrips, 2" x 2" slides, handmade slides, still pictures, graphic materials, the bulletin board, clippings from the news, the droodle board, the electric board, the chalk-board, and free and inexpensive materials. Chapter XI deals with the content of the modern chemistry curriculum. It proposes examples of content which would be vital for students in Iraq.

Part IV contains chapter XII only. This chapter is designed to show how to bridge the gap that presently exists between actual situation of chemistry teaching, as described in part I, and modern theory and practice as proposed in Part II and III of the thesis.

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PART I

PRESENT SITUATION OF CHEMISTRY TEACHING

IN IRAQ

CHAPTER I

THE BACKGROUND OF EDUCATION IN IRAQ

<u>The Educational System</u>:

In Iraq, all levels of public school systems, from kindergartens through colleges, are under the control of the Ministry of Education. The administration of the public school system is highly centralized. However, there is a slight trend towards decentralization of financial matters of the primary schools. Other than this, it is the Ministry of Education that issues regulations, instructions and orders, and is responsible for the appointments, promotions and dismissals of teachers, the founding, financial support and closing of public schools, the determination of curriculums and textbooks, the training of teachers, and the formulation and grading of public examinations. This intensive government control, determines the curriculums, the policies, and methods of public and private schools.

Public schools are completely free and are open to all students regardless of race, religion, social and economic status. Textbooks are given to all students whose grades are above the average. Others must still pay for them. Copybooks, pencils etc. are now being given to all students without cost. In many poor localities, a good number of schools are providing students with a free meal. Through such practices, the Ministry is striving to equalize opportunity to all children who are of school age.

The Educational Ladder

There are some isolated kindergartens in Iraq which are public, but in the main the educational ladder is based on a primary school which children enter after completing the sixth year of age and attend for six years, and a secondary school of five years, and a number of colleges of three to six years. There are also some vocational schools. The secondary school consists of two units: an intermediate unit of three years duration, and a two year preparatory unit.

The Public Examinations

Public examinations are held at the end of primary, intermediate, and preparatory units of schooling. They are supposed to be a check by the Ministry on the standards of achievement of the schools and also serve to keep private schools in line with the programs and policies of the Ministry. Government certificates issued on the basis of passing grades in these examinations are the only passport from one school unit to the next. Questions for these examinations are formulated by the "Department of Examinations" in the Ministry. The importance of these examinations is so magnified that they tend to be ends in themselves. On the whole, students and teachers become reluctant to pursue studies which are not likely to be included in the public examinations. School education , especially in the year of examination, becomes to a large extent a preparation for the examination. All questions are of the memorization type; things studied in the textbooks are to be reproduced on paper. Technical skills, abilities other than mental ability, attitudes and behavioral development in its broadest sense have no place in the public examination's evaluation of students.

The Curriculums:

The curriculums taught in all the schools of Iraq are the same except for a few modifications in schools located in Kurdish or Turkish localities.

The Ministry of Education lays down the entire curriculum in detail. This is done through the "Department of Curriculums and Textbooks". Teachers are not called upon to participate in the construction of the curriculums except in rare instances when they participate in writing a textbook on a certain subject.

The Textbooks:

The same department which works out the curriculums also issues the official textbooks which embody the prescribed curriculums. The textbooks are followed closely, lesson by lesson and chapter by chapter. Little , if any, reading is done outside the textbooks. The textbook subject matter must be apportioned properly over the academic year. When an inspector comes, he requires that the teacher shall have covered a certain portion of the curriculum as contained in the textbook. Acceleration beyond the required pace is not tolerated any more than lagging behind it.

CHAPTER II

OBJECTIVES AND PRACTICES OF THE SECONDARY SCHOOL IN IRAQ

Introduction

As mentioned before, the secondary school of Iraq consists of two units, intermediate and preparatory. Both units end with a public examination and offer a certificate. Holders of the final preparatory Baccalauriate certificate are qualified to enter any college which will accept the general average of their Baccalauriate examination grades, and any combination of grades in special subjects which the college requires.

In order to understand the role which the secondary school of Iraq is intended to play, it is necessary to examine the objectives formulated by the Ministry of Education. These objectives are listed at the beginning of the syllabi for both the intermediate and the preparatory schools where they are stated in the form of "directives-for-teachers".

Those aspects of the directives which pertain to the objectives of the secondary school will be translated and criticized. The purpose of such critique is:

1. To determine whether such objectives are adequate for the secondary school of Iraq.

2. To determine whether actual practice in schools does lead

to the achievement of these objectives.

Because, the objectives of the intermediate and preparatory units of the secondary school are stated separately in the syllabi of the Ministry of Education, they will to be treated separately in this chapter.

A. OBJECTIVES OF THE INTERMEDIATE SCHOOL

The following objectives are translated from the official syllabus of the intermediate school. [1]

The general objectives of the intermediate school are:

1. To increase the general cultural learning.
2. To prepare for the next unit of schooling (i.e. preparatory unit).

<u>Critique of the General Objectives of the Intermediate School:</u>

The two general objectives of the intermediate school, namely, "cultural learning", and "preparation for the next unit of schooling" are of little aid to the teacher. They are expressed in terms too broad and hazy to be understood and translated by the average teacher into classroom activities which would result in the accomplishment of these objectives. It is difficult to interpret what constitutes the Ministry's idea of "cultural learning" or "preparation for next studies".

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1. Ministry of Education of Iraq, Intermediate School Syllabus Baghdad. Government Press, 1950, p.1.

Little or no attention is given by the teacher to such broad and undefined objectives. Rather, the official curriculum is followed, with teachers taking it for granted that this procedure will achieve whatever objectives the Ministry may have in mind.

To leave the intermediate school teacher without clear and definite aims is to leave him at loose ends. In such a situation, the entire educational enterprise in the intermediate school becomes an undirected effort whose results are dictated largely by chance.

To quote further from the official syllabus:

> The duty of teachers is greater than mere provision of information. They have to provide their students with a right and balanced education, and therefore, the following aspects must be stressed:
>
> 1. The Character Aspect:
>
> Due to the psychological and social problems of the adolescent period, students in the intermediate school need individual attention and guidance. They also should be provided with a favorable enrironment, in which to live and work. Self-discipline, love of order and respect for regulations, must be developed in the students. Desirable social attitudes must also be developed. It is very necessary to develop the sense of responsiblity in the students by letting them participate in the duty of keeping order in the school, monitoring, and other school services.

Critique of the Character Aspect

The statement of the Ministry of Education demonstrates recognition of the fact that the adolescent period involves many psychological and social problems and that the adolescent needs individual attention, guidance and a favorable environment in which to grow. The purpose of this "individual attention", "guidance" and the "favorable environment" is to develop in the students self-discipline, a sense of responsibility, and desirable social attitudes.

Because it is not defined, the concept of "individual attention" is not clear to all teachers. The "guidance" mentioned in the syllabus is restricted to the following practice:

Each class (which may range from 40 to 45 in number) is assigned to a teacher for guidance. The teacher-guide's duties are:

1. Knowing the economic status of each one of the students.

2. Knowing the students' intellectual development as revealed through their grades in the various courses.

3. Making an estimate of the nature, inclination, personality, intelligence and potentialities of each student.

4. Urginghis students to work hard and behave well.

Practically all teachers are required to act as guides. In the teachers' colleges, however, they have received no special training in guidance of adolescents and youth. I.Q. tests, personality tests, and aptitude tests are never used as an integral part of guiding students. Thus, the entire guidance program is artificial, formal, and unscientific, and is carried on haphazardly and perfunctorily at best.

The "favorable environment" mentioned in the syllabus is left completely undefined. Presumably, a favorable environment is a healthy, restful, cheerful, and interesting place, which provokes thought, arouses interesting and stimulating questions, raises challenging problems, and promotes healthy mental, and psychological growth of the students. In short, the favorable environment must have desirable physical and psychological characteristics. What are these physical and psychological characteristics in Iraq?

a. Physical characteristics of the environment:

Most of the schools in Iraq are poorly built and poorly equipped for learning. Better buildings are being constructed, but even in these the classrooms leave much to be desired. The average classroom is a drab and uninspiring setting for learning. The furniture is fixed. Desks cannot be moved to make an informal circle for cooperative learning, for sharing experiences, and for evaluating one another's work. Rooms are small and over-crowded with students. There are small and dilapidated blackboards. Bulletin boards reflecting students' efforts, findings, and participation are virtually non-existent. Pleasant colors for walls and ceilings, stimulating materials such as posters, pictures, charts, exhibits, etc., are almost entirely lacking. There are no facilities for darkening and lighting rooms adequately. This is especially important if one looks forward to the day when motion picture projectors, slide projectors, opaque projectors, etc., may be used. At present, nothing of this sort exists in the schools.

The modern concept of the classroom is that it is a workroom; a laboratory where students work together, experience and experiment.

Iraq's average classroom is still a crowded, dull, and unstimulating place devoted to lectures, formal recitations, and, at rare instances, a few demonstrations done by the teacher. In short, it is not a favorable environment for learning.

b. Psychological characteristics of the environment:

Among the many possible contributing factors to a desirable psychological atmosphere, probably, the most important is a sound personal relationship between the students and their teachers. In Iraq, this relationship is a strictly formal one. The behavior of teachers both inside and outside the classroom is very authoritarian. Rigid discipline is demanded by almost all teachers. Most of the teaching follows the read-write, listen-speak routine. Other than this, there is very little student participation in activities and experiences. Teaching in Iraq is not a two-way process where there is free communication between the students and their teachers; where teachers are sympathetic guides of the activities of their students; where there is sharing of experience between students themselves and between students and their teachers. Teaching is not related to the interests and needs of the students. Rather it is of the formal, bookish type. The textbooks, with their exercises and problems, comprise almost the entire course of study.

Social life inside the school is not consciously directed. It goes in a hit-or-miss fashion, and no one seems to consider it in any sense a part of the educational process. There are some student societies, but they incorporate a limited number of students. More often than not, one or two parties given during the year represent the sum total of organized social effort. The idea that students' social energies can be directed toward learning the important values of co-operative effort has not yet made its appearance. Except for the sporadic parties above mentioned, there are rarely any activities involving common goals and satisfactionsfor the group.

As regards the "Self-discipline" which teachers strive to inculcate in students, it is a negative one. Students keep within rigid disciplinary codes as a result of fear of punishment. Instead, conformity to rules and regulations should be the result of an inward mental and psychological maturity which elicits enlightened cooperation and respect for others, and does not depend on an ever-present threats from outside. Discipline and positive character-building are actually synonymous. Discipline is the expression of gradually increasing social maturity. It is positive rather than negative. Therefore, in searching for evidence for the development of discipline it is necessary to look for what desirable behaviors the student has developed, rather than what he refrains from doing.

As to the "sense of responsibility" mentioned in the Ministry's syllabus, very little is undertaken by the school to develop it in the students. There is no student council. Social activities for which the students are responsible are few. The task of monitoring cannot be considered as "taking responsibility" for it is anexperience provided for the entire year to only one student out of a class of40to50 students.

The previous evaluation of the "character aspect" has shown that the Ministry's concept of a student with good character is he who has self-discipline, a sense of responsibility and desirable social attitudes. The Ministry also deems it essential that students grow and learn in a favorable environment, that they should be guided, given individual attention and provided with responsibilities. However, previous critical analysis of Iraq's situation shows that school environment is not a favorable one, that guidance is superficial and unscientific, and that opportunities for taking responsibilities and for participation in social activities which would develop desirable social attitudes are very few. In other words, the positive measures undertaken by the school to develop students' characters are very limited and deficient. Thus, the development of the student's character is left to chance, sporadic teachers' precepts, home effects, and street effects.

To quote further from the official syllabus:

> 2. <u>Intellectual Aspect</u>:
> Students' self-reliance and ability to study independently must be developed as much as possible. Adequate assignments in the textbooks and outside the textbooks must be given and explained to the students who should be held accountable for the preparation of the assignments.

<u>Critique of the Intellectual Aspect</u>:

It is a common understanding among teachers, especially secondary school teachers, that the students must "depend upon themselves" in their study. By this they mean that after assigning the lesson, the students must read it and understand it from the textbook before coming to the next day's class. Thus "independence" in this sense means ability to understand clearly from the words of the textbook alone. This is a great fallacy, but it characterizes the teaching-learning process which takes place in the schools of Iraq. It has been conclusively demonstrated that clear learning does not come through words alone, for words are symbols which represent an object(such as silver chloride) or a quality (such as pink) or a process(such as osmosis) or a law(such as the common ion effect). However, the word is not the object, quality, process, or law, but only the name for it. The student's ability to speak, hear, read, or write the word does not necessarily mean that he understands what the the object, quality, or process is. Teachers are often tempted to think that because students can manipulate words properly, they therefore know what these words mean. If the student does not have experience with the objects, qualities or processes about which he reads or hears, words will mean nothing to him. Dale[1] and Wittich and Schuller[2], for example, adequately vindicate the fact that <u>the basis of all</u>

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1. Dale, E. <u>Audio-Visual Methods in Teaching.</u> New York: Dryden Press Inc., 1954. pp. 95-105

2. Wittich, W.A. and Schuller, C.F., <u>Audio-Visual Materials-Their Nature and Use.</u> New York: Harper and Brothers publishers, 1953 pp 16-35

understanding, thinking, and attitude formation is real experience. Therefore, it is a grave mistake to act on the fallacy that learning may arise out of reading or hearing divorced from personal experience. To send the students to the textbook only and to consider the textbook (rather than concrete or semi-concrete experiences) as the royal road to learning results in three things:

1. Verbalism; the use of words without fully understanding their meanings.

2. Lack of ability to use such verbally acquired material in real-life situations.

3. The habit of uncritically accepting the verbal formulations of other people. Therefore, critical thinking and the scientific spirit cannot possibly be developed.

To quote further from the official syllabus:

> 3. Developing sportsmanship in the students:
> Many teams must be organized in the schools. Every student must be encouraged to participate in a game suitable for him.

Critique of "developing sportsmanship"

Although teams are formed in the schools, these teams involve only a limited number of students. Others find their own recreations which are often undesirable. Examples are: frequenting coffee-shops; strolling about in the streets; playing in unclean or unsafe places; etc.

To quote further from the official syllabus:

> 4. Hobbies:
> Teachers must encourage students to develop the hobbies which they already have.

Critique of Hobbies:

No more need be said than that hobbies which students have are usually pursued without much interest or guidance on the teachers' parts.

Quoting further from the official syllabus:

> Conclusion:
> In short, the intermediate school should contribute actively to the growth of the students in every respect whether it is mental, spiritual, social or literary. The duty of the teacher is to recognize all these aspects.

B. OBJECTIVES OF THE PREPARATORY SCHOOL

The following objectives are translated from the official syllabus of the preparatory school: [1]

The general objectives of the preparatory school are:

1. To prepare the students for higher education in colleges.
2. To provide them with a general cultural learning which would qualify them for good citizenship.

Critique of the General Objectives of the Preparatory School:

The critique previously applied to this aspect in the objectives of the intermediate school applies also to these

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1. Ministry of Education of Iraq, Preparatory School Syllabus. Baghdad: Government Press, 1954, p.1

statements for the preparatory school.

To quote further from the official syllabus for the preparatory school:

> Because of the above mentioned general objectives, careful attention must be paid to the following:
> 1. The scientific spirit:
>   Students must be trained to be independent in study and research. The scientific spirit must be cultivated in them. Therefore, they must learn to be accurate in their verbal and written expression. Students should develop the habit of seeking evidence for the ideas they hold, so as not to speak unthinkingly.
> 2. Logical thinking and critical analysis:
>   Students must be trained to think logically and critically. They must be made to think inductively and deductively and to analyse critically the outcomes of their thinking.
> 3. Experimental attitude:
>   Students must be trained in accurate observations and experimentation in laboratories and in the natural environment.

Critique of "the Scientific Spirit", Logical Thinking" and "Experimental Attitude":

The scientific spirit, logical thinking, and the skill in observation and experimentation all pertain to the development of problem solving skill and the attitudes and ways of thinking which are always interwoven with the scientific methods of solving problems.[1] There is a general

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1. The following is the writer's summary of the conventional steps of the scientific method of solving problems:

   (1) To sense a problem, a perplexing situation.
   (2) To define the problem clearly.
   (3) To collect data relevant to the problem by experimentation and careful observation. Past experience also may be drawn upon.
   (4) To organize and evaluate data.

(cont'd)

agreement among many present-day educators that to develop in the students the skill of problem solving and the scientific spirit,[2] they should be actually involved in the solution of practical problems. When a student has a problem in which he is interested, collects data about this problem through experimentation and observation, waits for sufficient evidence, formulates a hypothesis, tests his hypothesis, generalizes and applies the new knowledge, then, he is actually following a scientific method. When a student undergoes an adequate number of such experiences, the scientific spirit, logical thinking, and experimental attitude will grow in him gradually and inevitably. In short, the mind cannot be developed in a vacuum. It has to deal with problems, if it is to develop.

(cont'd)

(5) To set an explanation or a hypothesis.
(6) To test the hypothesis by further investigation.
(7) To discover principles and basic truths.
(8) To apply these principles to specific cases.
It is important to note that the first seven steps of thinking are usually called <u>inductive thinking</u>, which strictly means that thinking moves from the particulars (a considerable number of data) to the general (the principle or law). The last step is usually called <u>deductive thinking</u> which means that thinking moves from the general principles to the particular cases to which the principles apply.

2. In general, writers on the subject agree that elements of the scientific spirit or attitude are:

   (1) Freedom from bias, prejudice and superstition.
   (2) Open-mindedness.

(cont'd)

The scientific spirit, logical thinking, and experimental attitude will not be developed in the students when their main experiences are reading words in the textbook and hearing words from the teacher. Nor does a cut-and-dried laboratory exercise help to develop a scientific spirit or a skill in problem solving. In Iraq, a demonstration or an experiment is judged by its conformity to the words of the textbook-a procedure diametrically opposed to the scientific point of view. Only a few experiments are carried out by the students. Besides, when any experimenting is done, it is done in a formal way, according to a prescribed method. Generally, laboratory sessions, when they exist at all, follow exhaustive readings and class periods. The demostration or experiment in the laboratory is a kind of anticlimax. The laboratory is never used to find evidence which may help in the solution of a real problem. Since students already know the "approved" textbook outcome of an "experiment", real demonstrations or experiments are regarded as activities with too many potentialities for

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(cont'd)

(3) Critical-mindedness.
(4) Intellectual honesty.
(5) Belief in cause and effect.
(6) Objectivity.
(7) Willingness to change beliefs when new evidence is found.

"going wrong". The purity and precision of the textbook is regarded by both teachers and students as a much safer(though less scientific) type of learning. Because the means for achieving them are totally inappropriate, the "scientific spirit", "logical thinking", and "experimental attitude" are almost never achieved.

To quote further from the official syllabus:

> <u>4. Foreign Language:</u>
> Due attention must be paid to teaching the foreign language well[1] because of its importance to modern living and higher education.

<u>Critique of Foreign Language Teaching:</u>

Present teaching of the English language does not enable secondary school graduates to continue their education through this language, nor does it enable them to use English for practical purposes.

Quoting further from the official syllabus:

> <u>5. Responsibility:</u>
> Many school and community services must be entrusted to students to develop their sense of responsibility.
> <u>6. Social Development:</u>
> Social, moral and spiritual ideals, and intense patriotism must be developed in the students.
> <u>7. Hobbies:</u>
> Students hobbies and special talents must be encouraged and developed and related to courses of studies as muchas possible.

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1. The only foreign language taught in the schools of Iraq is the English language.

Critique of "Responsibility", "Social Developments", and "Hobbies":

The critiques previously applied to these same aspects of the intermediate school objectives apply also to these statements for the preparatory school.

To quote further from the official syllabus:

> 8. Aesthetic and Social Appreciation:
> Students social and aesthetic appreciation must be developed through appreciation of arts and fine social behaviors.

Critique of "Aesthetic and Social Appreciation":

No more need be said than that modern methods for developing appreciation are not followed in Iraq. This matter is left to chance and to each student's own disposition.

Quoting further from the official syllabus:

> 10. Conclusion:
> Teachers are responsible for educating the nation's youth and equipping them with the best that a school can offer. Students must be educated mentally, morally, spiritually, physically and patriotically. The teacher's duty is not restricted to teaching inside the classroom, he must also observe the students and guide them in every aspect of life.

C. GENERAL COMMENTS ON THE OBJECTIVES OF THE SECONDARY SCHOOL

So far, the objectives of both the intermediate and the preparatory schools have been discussed and evaluated in terms of what actually goes on in schools. This critical analysis of the situation in Iraq has shown that the objectives of the secondary school — as a Minister of Education once confessed to the writer — are merely "ink-on-paper".

Modern education names the secondary school as the "school of the adolescent" and considers it as one stage of education. Consequently, the objectives for the whole secondary school period should be one and the same. Objectives should not be separated into two sets, and they should not be different for both the intermediate and preparatory units of schooling. "Guidance", and "individual attention" for example, are as important for the preparatory school adolescent as they are for the intermediate school adolescent. In Iraq they are recommended only for the intermediate school adolescents. Again, "scientific thinking" and "scientific attitude" should be stressed in the intermediate school as much as they are stressed in the preparatory school. In Iraq, they are recommended only for the preparatory school students. In fact, scientific thinking and scientific attitudes can be developed even in the primary school. The child is an original researcher whose mind is full of curiosity and questions and whose hands are ready to manipulate and experiment. If the school capitalizes on this aspect in children, their scientific thinking and scientific attitudes certainly will be developed.

Moreover, the objectives for the secondary school in Iraq are seriously deficient, for the function of the secondary school in a democratic society, as Iraq purports to be, is much more extensive.[1]

Iraq's objectives of the secondary school besides being unclear, deficient and far from being achieved to a satisfactory degree, are also not in line with modern educational theory. Iraq's education is a part of its government system which is democratic. Therefore, education ought to have the clear objectives which a democracy strives to achieve. Education in a democracy strives to develop people into well-adjusted, capable, and socially worthwhile citizens. Iraq's education in the secondary school strives mainly to develop people who are:

1. cultured,
2. prepared for further studies.

In practice, the first objective merely means that students have to study a definite number of courses. These courses consist of "stuffing the mind" of the students with information, a great deal of which is not useful in their own

1. Chapter VI will deal with modern objectives of the secondary school in a democracy.

lives. This stuffing of the mind is even more pronounced in the preparatory school than in the intermediate school. Students' interests, aptitudes and basic needs are largely neglected. All students must take the same program whether it fits them or not. This demonstrates a complete neglect of modern views of education and its functions.

The second objective to-prepare for further studies-is in reality the main objective. However, there are several shortcomings to such a blanket objective, as follows:

1. The number of secondary school graduates who go into colleges is small as compared with the total number of graduates.[1] This is because colleges are few in number, and the few existing colleges are small and can accept only a limited number of secondary school graduates on a competitive basis.

2. A good number of students drop their schooling at the end of the intermediate school or during their preparatory schooling.

The above mentioned factors make it unwise to consider the main aim of secondary education as "preparing for further studies."

Secondary school graduates who do not enter colleges find themselves in a very difficult situation. They have no vocation; the secondary school has not helped them to develop interest and competence along any line. All their education has been "cultural" and verbal.

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1. No official statistics are available on the percentage of the secondary school students who go into colleges.

D. FACTORS COMPELLING CHANGE IN THE SECONDARY SCHOOL OF IRAQ

It is evident that the educational program which the school offers to the students should be an outgrowth of the objectives, that is, the school program should be the means through which the educational objectives are fulfilled.

Present practice in the secondary schools of Iraq does not fulfill the objectives of the secondary school set forth by the Ministry of Education. Further, the objectives of the secondary school are not adequate for the youth of Iraq. Therefore a change in both the objectives and the program of the secondary school seems to be imperative. Whether this change is imperative depends upon what we ask of education. If our instructional program is to consist only of facts, little reason exists for changing the program except as some new facts prove themselves worthier than some older facts. But if the school program is to be derived from an analysis of society and students' personal-social needs as these are related to broader social problems and conditions, then a change in both the objectives and the program of the secondary school is imperative. Education, in Iraq, should help people to live better lives and build better societies; it should induct children into the accepted ways of the culture and provide them with the insights and skills necessary to improve this culture.

Chapter VI will discuss the modern objectives of the secondary school which the writer considers essential for a country committed to democratic ideals.

This section will point out some of the factors that need be seriously considered by the secondary school if education is to be made responsive to the needs of youth, the needs of the country and the demands of modern living in Iraq. The factors which will be considered in this section are those which compel Iraq to change and improve the educational objectives and practices of the secondary school. These factors are:

1. The Urgent Need for Improving Society

It has been demonstrated that the school can have an active part in the improvement of living conditions in the community.[1] Hence, the modern concept of the community school which considers the role of the school, that of helping both directly and indirectly to improve living for all in the community is making its appearance. The social and physical conditions of living in Iraq need a great deal of reform and improvement. It is, therefore, regrettable that the educational practice in Iraq is still exclusively concerned with transmitting to students definite amounts of factual material contained in textbooks. If the pressing need for improvement of society's conditions are seriously considered by the schools of Iraq, then a change in present day educational practices is very necessary. However, progress towards the implementation of this modern educational

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1. This fact is well explained in the following book: Association For Supervision and Curriculum Development. Action For Curriculum Improvement. Washington 6, D.C. 1951 Yearbook. Chapter I and pp. 33-35.

concept can be made gradually.

2. Changing School Population:

In 1922 the number of secondary schools of Iraq was only four, and the number of students enrolled in those schools was 243. In 1955, there were 215 schools, and number of students attending these schools was 53,121.[1] This shows the tremendous increase in secondary school population. At the beginning, Iraq's secondary schools were fee-charging schools, thus only attended by people who could afford to. But nowadays, they are free and open to all classes of people. The government is following every possible method to encourage people to send their children to schools. The school population nowadays represents every sort of mental ability and widely varied needs, capacities and interests. It is no longer an intellectual or class aristocracy. So schools today need to develop measures to meet the more diverse needs of their populations, hence a change in the school program must take place.

3. Widened Field of Knowledge:

The new contributions to knowledge which have resulted from research in recent times have made necessary a broader inclusiveness in the program of all educational institutions. Recent developments in science, for example, make it necessary to revise old courses for the purpose of including what is of direct use and of vital importance to current social or eco-

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1. Ministry of Education of Iraq, Yearbook of Education, Baghdad Government press, 1955.

nomical or even political living. Knowledge that is no longer useful or valid should be removed.

4. Changing Nature of Iraq's Society:

The secondary school of Iraq is supposed to be a period of planning because standards that are set by the colleges, the state, and the community agencies now begin to confront the student directly. It is, therefore, necessary to draft the education of the secondary school student in terms of these standards as well as of his abilities and future life plans, needs and opportunities. Today, opportunities of youth of Iraq are wider and more varied than 20 years ago. More and more modern industries such as textile, leather and cement industries are being founded. Agriculture and business are being modernized. Great developments such as the building of dams, roads, bridges, factories, etc., are in progress. Thus provisions for the country's needs and the varied needs and preferences of its youth should be made in the secondary school program, if education is to serve its purpose.

Besides, the present generation of Iraq is confronting many of the inevitable problems that are indigineous to periods of transition. Much that was once good and solid has been too quickly destroyed, and in its place have come only uncertainty, frustration, and slackened morality. The adoption of western culture has left young people at loose ends, for they have been uprooted from their own culture and are supposed to grow in a mixture of cultures for which they have not been prepared.

Here lies one of the gravest responsibilities of our schools, namely, to make possible the integration of students' lives around values derived from a synthesis of the best elements in the Arabic culture and the new Western culture. However, this necessitates a thoroughgoing study of our culture and system of values, to render them more compatible with the demands of modern living.

Although the above-mentioned problems are pressing, Iraq's secondary schools are nevertheless detached from society. They do not recognize the fact that, outside the secondary school lies the community of which the student will soon be a part. In practice, they fail to educate the student for home life, community life, and effective citizenship. This, of course, reveals the urgent need for change in Iraq's educational planning and practices.

5. Changing Theories Of Learning:[1]

In the final analysis, the goodness of the school program is determined by the learning that takes place. Hence, an understanding of the learning process is essential.

At least three concepts of learning have dominated curriculum practices everywhere, namely learning as memorization, learning as mental discipline, and learning as experience. The first two theories, although discredited by research still are the actual theories behind most of Iraq's school practices.

Each one of these three theories will be described briefly:

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1. Most of the ideas in this section are derived from: Saylor I.G., and Alexander W.M. Curriculum Planning New York : Rinehart and Co., Inc., 1955, p. 186.

a. Learning As Memorization:

This is an early theory of learning which considered the mind as a store-house for knowledge. Learning, under this concept, was storing, the means of storing is memorization. Once fully memorized, material was "learned" and therefore, ready for use when needed. Under this theory, the curriculum is divided into subjects contained in logically organized textbooks. "Mastery-of-the-text" is the usual practice.

Research[1] has shown that after two years, a person forgets as much as 80% of what he has "learned" through mere memorization. The store-house concept of mind is also discredited on the basis of studies about learning factors and forgetting and retention. Modern education does not deny the role of memorization in learning, but, however, it places emphasis on understanding first and remembering later so that what is remembered may be of use.

Although the theory of learning as memorization is discredited by research, yet it is the major theory upon which school practices in Iraq are based.

b. Learning As Mental Discipline:

This later theory puts stress on exercising or disciplining the mental faculties. Thus one was supposed to cultivate the faculty of reasoning through its exercise in any way; that of memory through miscellaneous memorizing; that of imagination through imagining anything; and so forth. Under this concept, subject matter is only important to the extent

1. Ibid. , p. 187 .

that it trains the mind. Many research studies have rather completely denied the theory of mental discipline, but difficult and impracticable tasks to exercise the mind are being assigned in Iraq today.

c. Learning As Experience:

Modern education stresses the concept that learning occurs through experience. The concept of learning through experience may be more fully defined as follows: "Learning consists of the changes in an individual — his knowledge, skills, attitudes, ways of his own behaving — that result from his experience."[1] Thus the ultimate purpose of the school program is to affect certain desired changes in learners. The curriculum under this concept should be a series of rich experiences provided for changing students' behavior.

In the above mentioned definition of learning, several emphases should be noted.

(1) All possible changes in all aspects of behavior — physical, emotional, mental — are involved.

(2) Learning is an individual matter for it results from goal-seeking activity, and goal seeking activity of individuals can never be identical because individuals differ in goals, maturities, and other factors.

(3) Changes in the individual result from his experiences.

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1. Ibid., p. 188.

To change students' behaviors, teachers must therefore provide appropriate experiences for them.

This new theory of learning necessitates changing a great deal of the obsolete practices followed in Iraq. It is no more defensible in Iraq to follow such practices as the rather complete reliance on rote memorization, the neglect of the emotional, social and aesthetic sides of the student's education, and the failure to provide appropriate learning experiences.

CHAPTER III

OBJECTIVES OF CHEMISTRY TEACHING IN IRAQ

Introduction

The Ministry of Education has not clearly formulated the objectives of chemistry teaching as such. However, in the official syllabi of the intermediate and the preparatory schools, there are numerous "directives-for-chemistry-teachers." These directives consist of statements telling chemistry teachers what to do and what not to do, sometimes with reasons. Many of these statements consist of precautions and practical instructions which the teacher must follow. Examples are: wearing an overall, having first-aid equipment at hand, protecting students from poisonous compounds, and so forth.

However, from many of these statements may be inferred what the Ministry of Education intends to achieve through the teaching of chemistry in the intermediate and the preparatory schools.

Moreover, many of these statements show what methods are approved by the Ministry for achieving the desired objectives. Those statements in the "directives-for-chemistry-teachers" which give clues to the objectives of chemistry teaching in the secondary schools of Iraq are the ones which have been chosen for translation and consideration in this chapter.

(In the next chapter, statements which give clues to the <u>methods</u> of chemistry teaching will be translated and considered.)

<u>Objectives of Chemistry Teaching In The Intermediate School As Inferred From The Official Syllabus:</u> [1]

> 1. The inductive method must be followed accurately in chemistry teaching. Practical experiments whether they are teachers' demonstrations or students' laboratory work, must precede theoretical facts.

The Ministry of Education apparently intends to develop in the students the habit of inductive thinking.

> 2. Learning of chemistry depends on two important bases; teachers' demonstrations, and students' individual laboratory experiments. The reason behind this is to make learning of chemistry permanent. Further, in every recitation period the teacher must give an adequate amount of the prescribed syllabus.

It is evident that the Ministry intends to impart to the students a definite amount of chemical information which will remain in their heads permanently. All the prescribed syllabus must be mastered by all the students.

> 3. Teachers must be resourceful and must improvise methods and experiments for each one of the lessons to the end that students' interest in chemistry may be aroused and the habit of accurate observation, sound thinking and correct inference may be inculcated in the students. Teachers must train students to depend on themselves in interpreting the results of their experiments.

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1. All quotations in this section are translated from the "directives-for-chemistry-teachers" listed in the <u>Official Syllabus of the Intermediate School</u>. p.79

It is obvious that the Ministry intends to secure the following results from chemistry teaching:

a. An interest in chemistry.

b. Habit of accurate observation.

c. Sound thinking.

d. Ability to draw correct inferences from the results of experiments.

> 4. Teachers must show how chemistry is related to daily lives of the students. Careful attention must be given to mentioning where different elements and compounds are found in Iraq, and what potential chemical industries may be created or developed.

Perhaps the Ministry intends to make chemistry functional in the daily life of the students, but this is not stated explicitly.

> 5. Teachers must train their students to express chemical facts in precise and accurate Arabic.

It is evident that the Ministry intends to train the students inaccurate and precise scientific expression through the medium of the Arabic language.

<u>Objectives Of Chemistry Teaching In The Preparatory School As Inferred From The Official Syllabus:</u> [1]

It is much more difficult to infer the objectives of chemistry teaching in the preparatory school than to infer

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1. All quotations in this section are translated from the "directives-for-chemistry-teachers" listed in the *Official Syllabus of the Preparatory School.* p. 75

them for the intermediate school. Most of the "directives-for-chemistry-teachers" are practical instructions. What the Ministry intends to achieve is not clear at all. Nevertheless, from the following quotation the objective of the preparatory school chemistry teaching may be inferred.

> 1. Teachers must manage to finish the prescribed syllabus by striking a balance between the time allotted to recitations and that allotted to laboratory work.

No more can be inferred from such a statement than that the objective of chemistry teaching in the preparatory school is merely to give students a prescribed amount of chemical facts, most of which are verbal description of chemical processes, qualities and laws, perhaps for the purpose of preparing students for colleges which require chemistry.

So far, we have discussed the objectives of chemistry teaching in the secondary school of Iraq as the Ministry of Education presumably sees them. In short, these objectives are to develop in the students.

1. The habit of inductive thinking.

2. Long-remembered understanding of chemical facts.

3. An interest in chemistry, the habit of accurate observation, sound thinking, and the ability to draw correct inferences from the results of experiments.

4. Functional understanding of chemistry.

5. Precise scientific Arabic expression.

6. An understanding of a prescribed amount of chemical facts.

CHAPTER IV

METHODS OF CHEMISTRY TEACHING IN IRAQ

Introduction

In the previous chapter, it was mentioned that in the official syllabi for intermediate and preparatory schools, there are numerous "directives-for-chemistry-teachers." Many of these directives consist of statements from which may be inferred the methods and practices of chemistry teaching which are recommended by the Ministry of Education. Such methods and practices are supposed to achieve the desired objectives of chemistry which are listed in the previous chapter. These statements of methods and practices will be translated and considered in this chapter. Further, this chapter will discuss the actual methods and practices followed by chemistry teachers and consider whether such methods and practices can achieve the Ministry's objectives of chemistry teaching.

The methods of chemistry teaching recommended for the intermediate and the preparatory schools will be considered separately.

A. METHODS OF CHEMISTRY TEACHING IN THE INTERMEDIATE SCHOOL AS INFERRED FROM THE OFFICIAL SYLLABUS[1]

1. The inductive method must be followed accurately in chemistry teaching. Practical experiments, whether they are teacher's demonstrations or students' laboratory work must precede theoretical facts.

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1. All quotations in this section are translated from the "Directives-for-chemistry-teachers" listed in the <u>Official Syllabus of the Intermediate School</u>, p. 79.

Although this statement seems to be in line with modern educational theory, the plain fact is that almost no teachers pay it any heed.[1] Among the many reasons behind this are the following:

a. Teachers themselves have neither had any experience in the inductive method of thinking in their secondary schooling nor in their college work. Teaching in both is of the formal deductive type. The laboratory is used only to fix in mind theoretical knowledge which already has been studied, or to demonstrate the truth of the knowledge embodied in books. It is not used for any problem-solving or student research which might result in the inculcation of the scientific spirit and the habit of inductive thinking.

b. Schools are usually poorly equipped. Most schools lack either a laboratory or chemicals or both.

c. The three hours per week allotted to the chemistry course in the intermediate school are hardly enough to cover the curriculum even on a purely lecture-discussion basis.

Because teachers do not follow an inductive method in their teaching, the habit of inductive thinking is almost never developed in the students.

2. Teachers must give subject matter in an organized way

1. See critique of the "Scientific spirit", "Logical thinking" and "Experimental attitude" in Chapter II, pp.17-20.

The word "organized" as used in this statement is not defined. However, the organization of the textbook and the usual practice (which is to follow step by step the organization of the textbook) shows that the organization usually followed is the logical rather than the psychological organization. Students' interests, needs, and daily problems are completely neglected in the chemistry coursesgiven to them.

3. Teachers must use audio-visual materials such as pictures, diagrams, charts and specimens. Demonstrations and laboratory work are very important for illustrating chemistry. Chemical industries in Iraq should be visited.

It will be shown in later parts of the thesis that audio-visual materials and methods are rarely used in teaching chemistry in Iraq. A new audio-visual center has been established in Baghdad, but its services have not yet been extended to schools.

Student laboratory work in the intermediate school is virtually non-existent. Teachers use demonstrations as little as possible.

As regards field trips, there are many possibilities for them in Iraq such as petroleum fields, industries such as soap, cement, matches, and leather tanning industries, and places of chemical interest such as sulfur springs, calcium carbonate deposits and the like. However, these possibilities for field trips are never fully explored by teachers. Only a few schools can afford to visit petroleum fields, for example.

To cover the subject matter of the chemistry curriculum is the teacher's major concern. This practice of teachers certainly makes chemistry meaningless, abstract, uninteresting, and useless to students.

4. Subject matter must be explained in a simple way and must be made interesting.

Neither "simplicity", nor "interest" is defined in this statement. Besides, the idea of "making subject matter interesting" is not sound. Good teachers do not "make subject matters interesting", rather they connect their students' interests to the subject matter. This requires a keen understanding of the psychology of the students with whom the teachers are dealing.

5. Teachers must direct special attention to solving numerical exercises, which are the means of clarifying and illustrating chemical laws and other aspects of theoretical chemistry.

According to Twiss[1] laws are "condensed statements under which like facts and like relations between groups of facts are summed up. Hypotheses and theories are ways of describing facts". Therefore in order that students may

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1. Twiss, G.R., Principles of Science Teaching. New York: MacMillan Co., 1938, p.358.

comprehend the laws and theories Twiss suggests that they should first know "at least a considerable portion of the facts which the laws resume or the theories explain."[1]

Therefore, laws and theories are best understood when the student infers them inductively. To memorize the laws and to try to solve numerical exercises about them will not result in a clear understanding of the laws. They will soon be forgotten.

> 6. Teachers must show how chemistry is related to other school subjects, to students' daily lives, and to Iraq's present and potential industries.

In this statement the Ministry suggests the desirability of students seeing their entire curriculum as an integrated whole. However, this exhortation to the teacher seems to end the matter. Examination of official textbook reveals no deliberate effort to show this relationship of chemistry to other school subjects. Further, it seems that the Ministry intends to make chemistry functional in the daily life of the students, and tied down to what exist of present and potential industries in Iraq.

In fact, very little effort, if any, is exerted in this direction. Chemistry is still taught on an academic, formal and non-functional level. Primary emphasis is placed on memory processes and the acquisition of inert bodies of information.

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1. *Ibid.* p.358.

7. At the end of each lesson, the teacher must provide his students with a summary of the essential facts and concepts of the lesson.

This suggestion is not sound, because scientific inductive thinking would not be developed if such a practice were followed. By so doing, the teacher would give his student verbal pellets to be swallowed and regurgitated later on. Once a fact is attained inductively, the student should not be denied the training in thinking which comes from formulating a new idea in his own words. If he is given a cut-and-dried summary, he is more likely than not to memorize it without understanding.

8. "Tests must be frequent"

All tests are of the paper-and-pencil type, materials memorized are to be reproduced to the teacher. Many present-day science educators suggest the desirability of using demonstrations to test students understanding of science. They also suggest the use of problems which test students ability to use the inductive method of thinking.[1]

Nothing of this sort is used in Iraq to test chemistry students.

9. Laboratory Procedures.

a. Laboratory experiments can be flexible. Teachers may choose experiments according to the availability of chemicals and apparatus in their schools.

b. Experiments performed by the students in the laboratory must be related as much as possible to classroom work.

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1. For examples of such problems, see the book on <u>Science Reasoning and Understanding</u>. Published by WM C. Brown Co. Dubuque, Iowa, 1954.

c. Students must be given only simple apparatus for which they should be responsible.

d. Adequate instructions about the procedure of the experiments and about amounts of chemicals to be used must be given to the students.

e. Laboratory sessions must be divided into three successive intervals. The activities which constitute these three intervals are consequtively:

(1) The teacher asks questions about the the previous lesson.

(2) Students perform experiments, record their observations and draw their inferences. The teacher is supposed to help each one of the students individually.

(3) The teacher conducts a general discussion to straighten out any misconception on the students' part. He may also give the next assignment.

It is necessary to note that chemistry laboratories in the intermediate schools are rare. Instead there are demonstration rooms in many schools. Even when laboratories exist, intermediate school students are not given the opportunity to work in the laboratory. They are considered too immature to deal with chemicals and apparatus. Demonstrations are used at rare intervals. Teachers must manage to cover the subject matter of the chemistry curriculum. If time is available, students are to be permitted to see some demonstrations. Otherwise chemistry inevitably remains a theoretical mixture of symbols without referents, juggled about by mathematical operations which make the result even more obscure and intangible. The result of such a practice is that chemistry becomes a boring subject, simply because most of it is mental gymnastics. Students try in vain to gain a clear conception of a great number of facts which cannot possibly be learned except through first-hand experience. Such a practice in schools reveals that laboratory work, demonstrations and other valuable experiences are considered a waste of time. They are something which can be dispensed with without significant loss or harm to the students. Even when they are used, they usually follow exhaustive reading and class discussions. The student already knows the required answer or result.

Such practices in schools of Iraq certainly can not develop the "habit of accurate observation", "The habit of inductive reasoning", and "The ability to draw correct inferences" which the Ministry considers as important objectives of chemistry teaching.

B. METHODS OF CHEMISTRY TEACHING IN THE PREPARATORY SCHOOLS AS INFERRED FROM THE OFFICIAL SYLLABUS[1]

1. Teachers must manage to finish the prescribed syllabus by striking a balance between the time allotted to recitations and that allotted to laboratory work.

This statement shows that the Ministry recommends that the teaching of chemistry in the preparatory school be done on a verbal recitation basis with a few individual laboratory experiments. This shows clearly the low priority assigned to laboratory work. The laboratory periods are

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1. All quotations in this section are translated from the "Directives-for-chemistry-teachers" listed in <u>The Official Syllabus of the Preparatory School</u>. p. 75.

devoted to verbal recitations for the purpose of covering the subject matter of the chemistry curriculum. Teachers use such existing laboratories as little as possible. Students go to the laboratory only a few times during the year.

Moreover, the above-mentioned statement of the Ministry is a confession that the chemistry curriculum is overloaded. Otherwise no encroachment on laboratory periods would be necessary.

2. The teacher himself must perform some demonstrations during the recitation periods.

This statement stresses the fact that during recitations, the teacher himself must do some demonstrations. Why should not students participate in preparing for these demonstrations, in assembling apparatus parts, or actually replace the teacher in performing the demonstrations when they are not too complicated for them ? Students can help in various ways. To prevent them from any active participation seems diametrically opposed to the Ministry's above-mentioned objectives of developing responsibility, independence or trustworthiness. Also, it is not in line with modern educational theory which emphasizes the importance of students' active participation in their learning experiences.

However, these demonstrations are a few and are of the sugar-coating type, that is, they are performed merely to add a little flavor to the verbal knowledge already stored in the heads of the students. There is little general confidence in the educative value of these demonstrations.

3. Students must be trained to perform experiments by themselves, record their observations and inferences, and make sure that these inferences are <u>in conformity with what they have studied theoretically</u>.

This statement shows quite clearly that theoretical study precedes the work in the laboratory both in time and in importance attached to it.

It is self-evident that the outcomes of students' experiments are <u>never exactly in conformity with the formulations of the textbook</u>. To suggest the practice of squeezing one's results into line with a set of "right" or "approved" answers is to attack the very essence of the methods of science. In such an atmosphere we may breed science-worshippers, but we shall produce no scientists.

4. In their laboratory copy books, students should write according to the following organization:
a. The theoretical basis of the experiment.
b. Accurate and concise description of the experiment as the student himself has done it. A drawing of the apparatus must be included.
c. Results of the experiment with the necessary equations.

This statement shows also that theory comes first. Practice in the laboratory is secondary. Students cannot possibly write the theoretical basis of the experiment without being familiar with the subject. Furthermore, the arrangement of subject matter is as follows: physical chemistry (which is a number of laws and theories) is taught before metals, non-metals and organic chemistry. This is diametrically opposed to the "directives-for-teachers-of-chemistry" in the intermediate school syllabus, where teachers are required to follow an inductive procedure, that is, to begin with demonstrations and experiments before proceeding to theoretical study.

> 5. The existence of a chemical society in the school will encourage students to do research work under the guidance of the sponsor teacher.

The statement shows that the Ministry recognizes the importance of societies and co-curricular activities. What actually goes on in schools will be explained on p.139.

C. GENERAL COMMENTS ON METHODS OF CHEMISTRY TEACHING IN THE SECONDARY SCHOOLS OF IRAQ.

Up to this point the methods of chemistry teaching, which are recommended by the Ministry of Education have been discussed and criticized. It has been shown that what actually is practiced in the schools is far from what the Ministry recommends. Further, many of the methods suggested by the Ministry are deficient, and not well-defined. An example is the Ministry's suggestion of giving subject matter in an "organized" way. "Organization" there is left completely undefined. Similarly, the Ministry's suggestion to make subject matter "interesting" and "simple" is also a hazy suggestion. How "interest" and "simplicity" should be achieved is not explained to the teacher.

Moreover, the methods suggested for the preparatory chemistry course differ from and contradict the methods suggested for the intermediate chemistry course. For example, for the intermediate school chemistry, the Ministry suggests the inductive approach, while for the preparatory school chemistry the Ministry suggests the formal deductive approach.

Further, although the methods suggested to the intermediate and preparatory school chemistry teachers are apparently different, the actual practice in both schools is the same. The method of chemistry teaching in both schools may be briefly described as follows:

1. The teacher assigns so many pages in the textbook to be "learned" by the students.

2. They study the lessons at home.

3. Next day they "recite the lesson" before the teacher who questions and develops discussion as best as he can.

4. From time to time an examination is given to the students. The students write what they recall, deriving their answers to the questions from what the teacher said or what was in the book.

5. Rewards in the form of grades are given on basis of the pupils' ability to remember what the book contained or what the teacher said.

It is obvious that students do not "learn" by this method. They only memorize temporarily. The major goal of the students is "passing the examination." Obviously, a course of this kind is not studied for its educative value (i.e., for the desirable behaviors that the course is supposed to develop). Nor is it studied for its intrinsic worth; for facts that are of tested worth, and of interest and significance to the students. As mentioned above, demonstrations are rare in both intermediate and preparatory schools. Individual laboratory work is virtually non-existent in the intermediate school, while in the preparatory school it would not exceed five periods per year in number. Both demonstrations and laboratory work follow exhaustive reading and class discussions.

Investigation, real problem solving, and practical projects have no place in Iraq's secondary school chemistry courses.

When such are the methods used in chemistry teaching, it is natural that almost none of the Ministry's objectives of chemistry teaching, such as "inductive scientific thinking" "accurate observation", "correct inference" or even "retention of chemical facts for a long time" are achieved.

Later chapters of the thesis will suggest some of the modern objectives of a secondary school course in chemistry,

and will also explain some of the modern methods and mat-
erials to implement such objectives.

CHAPTER V

THE CHEMISTRY CURRICULUM IN THE SECONDARY SCHOOL OF IRAQ

Introduction:

Chemistry is taught in the secondary school in both the intermediate unit (to all students) and the preparatory unit (only to the science section students). Chemistry is taught together with other science courses. The following tables show the distribution of chemistry and other science courses and the lesson periods allotted to them.

Intermediate School

	First Year	Second Year	Third Year
General Science	6 hours/week		
Chemistry		3 hours/week	
Biology		2 hours/week	
Physics			3 hours/week
Hygiene			2 hours/week

Science Section of the Preparatory School

	Fourth Year	Fifth Year
Chemistry	3 hours/week	3 hours/week
Physics	3 hours/week	4 hours/week
Biology	4 hours/week	5 hours/week

A. CONTENT OF THE CHEMISTRY CURRICULUM OF THE INTERMEDIATE SCHOOL [1]:

The following subjects (which are contained in a textbook of 225 pages) are taught in the second year of the intermediate school. They are presented here in a condensed form. They are:

1. What is chemistry?
2. Matter; states of matter; classification of matter into compounds and elements, metals and non-metals; changes of matter; properties of matter; decomposition, combination; mixtures, solutions, and suspension, saturation, solubility, laws of solubility, separation of suspensions and solutions, distillation; what is matter made of; gas laws; the atom; reactions; formulas; equations.
3. Air and its constituents.
4. Oxygen.
5. Acids, bases, and salts.
6. Salts, neutralization, crystallization.
7. Hydrogen.
8. Water.
9. Chlorine.
10. Chlorine compounds.
11. Nitrogen; its oxides; nitric acid; ammonia.
12. Sulfur.
13. Sulfuric acid.
14. Phosphorous; phosphoric acid.
15. Carbon; its oxides; carbonates.
16. Carbon compounds; hydrocarbons.
17. Fuels; petroleum; gas fuels and flames.
18. Carbohydrates; cellulose industries; paper industry; rayon.
19. Alcohol; acetic acid.
20. Fats. Soaps. Proteins.
21. Silicon and its compounds; carborandum; glass; ceramics; cement.
22. Metals; their occurrence and metallurgy.
23. Iron and Copper.
24. Lead. Zinc. Aluminum.
25. Alloys and Amalgums.
26. Important metallic compounds:

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1. Ministry of Education of Iraq, Intermediate School Syllabus. Baghdad: Government Press, 1950, p.32.

Sodium carbonate and bicarbonate. Gypsum. Magnesium sulfate. Zinc compounds. Chlorides and oxides of Mercury. Important compounds of Iron. Blue ink. Copper sulfate. Alum. white lead and litharge. Silver nitrate.

B. CONTENT OF THE CHEMISTRY CURRICULUM OF THE PREPARATORY SCHOOL [1]:

The following subjects (which are contained in a textbook of 610 pages) are studied in the preparatory school. These subjects are covered in two years; parts one and two are taught in the first year and the rest are taught in the second year. The contents are presented herein a condensed form. They are:

Part one: Physical chemistry.

1. History of chemistry and introduction.
2. State of matter.
3. Solutions.
4. Chemical reactions laws. Atomic and molecular theory.
5. Molecular weights.
6. Chemical equivalents.
7. Atomic weights and equivalents.
8. Chemical symbols and formulas.
9. Chemical equations and calculations.
10. Aids, bases, and salts.
11. Chemical reactions.
12. Atomic structure and radioactivity.
13. Electrolysis and ionization theory.
14. Normal solutions.
15. Classification of elements and the periodic table.

Part two: Non-metals.

16. Hydrogen, water, and hydrogen peroxide.
17. Oxygen.
18. Air and nitrogen.
19. Halogens.
20. Sulfur.

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1. Ministry of Education of Iraq. Preparatory School Syllabus. Baghdad: Government Press, 1954, p.76.

21. Phosphorus.
22. Arsenic, Antimony, Bismuth.
23. Carbon.
24. Boron, Silicon, Glass industry.

Part three: Organic chemistry.

25. Organic compounds-Hydrocarbons.
26. Petroleum.
27. Alcohol, Ether, Organic acids.
28. Carbohydrates.
29. Oils. Fats. Soap.
30. Proteins and protein industries.
31. Fuels and combustion.

Part four: Metals

32. General properties of metals.
33. Alkaline metals.
34. Copper family.
35. Alkaline Earth metals.
36. Magnesium and zinc family.
37. Aluminum.
38. Antimony and lead.
39. Chromium and manganese.
40. Transition group: Iron, Cobalt, Nickel.

C. GENERAL COMMENTS ON THE CONTENT OF THE CHEMISTRY CURRICULUM.

The Curriculum Is Overloaded:

Examination of the content of both chemistry courses given in the secondary school school of Iraq reveals that much ground is attempted to be covered at the risk of superficiality and lack of understanding and formation of real scientific thinking, and the habit of penetrating to the real reasons . The curriculum of both courses is overloaded with facts, details, and generalizations . This is especially true of the preparatory school curriculum, where so many unnecessary compounds , facts and rare products, must be mastered by all students. Examples are: producer gas, hydrocyanic acid, cyanogen gas, perchloric acid, hypochlorous acid, phosphene gas, phosphor chlorides, too many details about metals and their occurrence in the world, various methods of metallurgy, many unnecessary compounds of such metals, and so forth.

Brin's process of preparation of oxygen from air as discussed in the official textbook of the preparatory school serves as a specific example of the waste of students time and effort on unnecessary bits of information. The textbook mentions in detail how the process was started on 1881. Then it discusses how that early method proved to be inefficient and how it was modified to a better process .

Why should students time and effort be wasted on an obsolete process which is no longer followed in industry ?

Examples similar to the one mentioned above are many and will not be mentioned because of space limitations.

Practically all teachers of chemistry complain about the inadequacy of the allotted time for covering the required subject matter. Although they follow a verbal "assignment-recitation" plan and perform only a few demonstrations and laboratory sessions, yet they can hardly finish all the required subject matter.

The curriculum is static:

The contents of the chemistry curriculum have been the same for many years. The content of the intermediate school chemistry has not changed for the last 12 years, and that of the preparatory school has not changed for the last 9 years. Since the last revision of these courses, significant developments in the fields of industry, research, and world affairs which are pertinent to chemistry have taken plase. For instance, the atomic energy has been liberated in the form of atomic and hydrogen bombs, and it is being used in every field of man's endeavor such as agriculture, medicine, industry, economic development and scientific research. While, many recent textbooks in high school chemistry emphasize this topic which is of great importance to human and to international affairs and which captures the interest of students, the chemistry curriculum of Iraq does not even touch on it.

Many recent developments in organic chemistry which carry vital implications to the students' own lives by contributing to such important areas as foods, drugs, plastics, and textiles, are overlooked in the chemistry curriculum of Iraq.

Subjects which are pertinent to Iraq and which are gaining more and more significance in the social and economic development of the country are not given due emphasis. Petroleum, for instance, has become the major source of the country's revenue. Also, it has become a determining factor in the economical, political and social affairs of Iraq. Yet, our chemistry curriculum gives it no more emphasis or space than the topic on the copper family or chromium and manganese.

<u>The Curriculum Is Non-functional</u>

The major shortcoming of the chemistry curriculum is that it fails to help students to live a better life. The curriculum is academic in nature; it mentions facts as abstractions. Application of chemistry in students' own lives and in the community life is largely neglected. Students are supposed to study chemistry as though it were "ancient history" — set apart from actual life, and from their problems, needs and experiences. It is erroneously assumed that once students recognize facts and generalizations of "pure chemistry", they will be able to recognize and utilize them in their daily living. Actually, students will not be able to make use of chemical facts and generalizatidns unless they are made to see the relationship of chemistry to the processes and actualities of their daily living.

In the 46th yearbook of the National Society for the Study of Education, functionality of the chemistry curriculum is highly stressed. There, it is maintained that the chemistry curriculum "should clarify the relation of chemistry to health, vocational pursuits, and to other aspects of living to which the subject matter of chemistry relates, and to which it contributes understanding."[1]

The chemistry curriculum of Iraq emphasizes facts, details, theories, principles and generalizations which will soon be forgotten. The reason is that teaching abstract facts as such fails to interest students, for they lack significance, vitality, and pertinence to students' daily lives.

A course emphasizing the chemistry of industry, soil, household, food, and similar subjects, besides being of direct use to students in their daily living will also capture their interests and enable them to grow in appreciation and understanding of the vital role which chemistry plays in their own life, community life, and in the affairs of their nation and of the world. On the same point Wells[2] says that:

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1. National Society for the Study of Education. Science Education in American Schools. 46th Yearbook, Part I, Chicago: University of Chicago Press, 1947, p. 199.
2. Wells, H., Secondary Sciences Education. New York: McGraw-Hill Book Co., Inc., 1952, p. 206.

> Everything studied in chemistry has potential or immediate application. The food students eat, the clothes they wear, the things they use (pencil, eraser, sharpener, comb etc.), all are influenced in development to an astonishing degree by chemical processes. Chemistry is important in the home, in the community, and in the life of each individual, and an alert chemistry class will show enthusiasm in discussion, experimentation, and in reference research, through realization of this truth.

Chemistry and living; yes, they can go hand in hand, and it is the task of the curriculum builders, and the teachers to extend chemistry out of the realm of pure symbols and formulas and into the dynamic aspects of students' lives; to fire them with zeal for something pertinent to their lives. Moreover, when the chemistry of industry, of the soil, of the household, etc., is emphasized in the secondary school chemistry curriculum, more and more of the students will be stimulated to specialize in these and related fields. Iraq needs such specialists very badly in its present stage of development.

Besides being related to everyday living and to students' real needs, the chemistry curriculum should include a wealth of materials and activities designed for use in developing the abilities and attitudes associated with the scientific method of problem-solving. Facts of chemistry alone, useful as they may be, are only one side of the educational value of a chemistry course in the secondary school. The other equally important side is the skill in probkem-solving which is highly needed by students living in a contemporary democratic society.

Problem-solving activities of the kind mentioned above are not provided in our chemistry curriculum. The textbook with its verbal descriptive content and numerical exercises together with a few demonstrations comprise the entire course of study.

The Curriculum Overlaps

The course of chemistry studied in the preparatory unit of the secondary school does not differ from the one studied in the intermediate unit, except in number of facts and details and some aspects of organization of subject matter. Both courses have a great deal in common. In other words, the chemistry course of the preparatory school is a repetition and enlargement of the one given in the intermediate school. This repetition does not seem to be supported by any worthwhile reason. It is only a waste of students' time and effort.

Instead of the two overlapping courses of chemistry, a single course given in the fourth year of the secondary school to which 7 hours per week are devoted, would be much more appropriate. (The same suggestion would apply to physics, which can be given in 5th year, and to biology, which can be given in 4th year).

In place of the isolated chemistry, physics and biology courses given in the intermediate unit of the secondary school, it seems more appropriate for our students to have general science; a course integrating physical, chemical, astronomical, and biological sciences and arranging facts, principles, and generalizations under significant units which center around major aspects of the environment such as: adaptation of living things to their environment; cause and effect relations; changes of the surface of earth due to natural phenomena; changes that take place inside our bodies; health and disease, etc.

D. GENERAL COMMENTS ON THE ORGANIZATION OF THE CHEMISTRY CURRICULUM.

Examination of the chemistry curriculum shows clearly that it is organized according to the logical development of the subject matter, that is, according to the logic of the scientist, and gives no thought to the psychology of learning. The curriculum does not recognize the interests, needs, and problems of secondary school students growing in Iraq's environment, that is, it neglects sources of students' motivation which are of paramount importance to learning. It is important to note, however, that whatever organization is used in the curriculum as contained in the textbook, it is usually followed indiscriminatingly by a great number of teachers. Therefore, a logical organization of the curriculum, as contained in the textbook, would mean more often than not a method of teaching that follows the logical development of the subject.

Unfortunately, too many students, especially younger students, do not find a significant purpose in the study of logically organized subject matter. Only mature and intelligent students will be able to find meaning in logically organized subject matter, and they do so when the subject matter serves some of their own purposes, as when such students plan to go to college, want to learn about a field in which they are interested, or want to gain prestige by being competent in the field. But the great majority of students will not be able to set such purposes for themselves. For them, the principal purpose of mastering subject matter becomes that of making a passing grade, or of avoiding criticism or punishment.

Such logical organization lends itself very readily to rote memorization. Provision for functional understanding and for integrating knowledge into meaningful wholes is lacking under such a formal setting. Opportunities for participating in problem solving also are not provided. In fact, organization of the curriculum is one of the main factors in the effectiveness of the learning that takes place.

To be psychologically sound, organization of the curriculum should not be made around material substances such as oxygen and hydrogen, but around fairly large units, each focussed upon some functional understanding or principle such as control of burning, nature of chemical change,[1] etc. Or even better, organization should be made around problems which are significant to learners. These problems will serve as challenges which provoke students' interests and incite them to participate in problem-solving activities. Effective and purposeful learning can be achieved through solving problems. Examples of such problems are: The chemistry of food and nutrition, the chemistry of cooking and food presemvation, and the like.

Further, when the curriculum takes into consideration the interests of the learners, their needs, and problems that they meet in their daily living or anticipate in their future living, such a curriculum provides a high level of motivation and is therefore psychologically sound. Besides, such a curriculum will not be only an inert body of information that is detached from the stream of students' lives. Rather, it will be highly useful to them, for it will help them meet life situations more effectively.

Contradiction with modern psychology of learning is evident, especially in the organization of the preparatory school curriculum. The curriculum begins with physical chemistry which is an abstract treatment of a number of chemical laws and theories such as gas laws, chemical combination laws, atomic weights and equivalents, theory of ionization, and so

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1. This idea is derived from: National Society for the Study of Education, op.cit., p.200.

forth. Then come more concrete studies such as non-metals, organic chemistry and metals. This is diametrically opposed to a well-established principle of learning, namely, that learning proceeds from the concrete to the abstract and not the other way round.[1]

Moreover, monotony and dull presentation characterise the whole material of the curriculum. When metals or non-metals are discussed, the discussion always begins with occurrence of the element, then it proceeds to methods of preparation, properties and compounds. Such a presentation kills the scientific attitude and habits of thinking, dulls the sharp edge of curiosity and interest.

As an example of the formality and the dull presentation of subject matter in our chemistry textbooks, let us take the topic on "electrolysis and ionization" presented in the textbook of the preparatory school. There, the subject is formally started by mentioning that those liquids which conduct electricity are called electrolytes, while those which do not are called non-electrolytes. After that, decomposition of electrolytes by electric current is discussed. Then, Faraday's Laws are discussed in their abstract form without a single application of them in industry. Then comes the theory of ionization in its abstract form. None of the phenomena for which the theory is an explanation, are discussed. Hydrolysis and the electro-chemical series end the topic.

On the other hand, a recent secondary school chemistry textbook[1] presents this same topic quite differently by relating it to students' experiences, and to what they see in the environment and use at home. Much attention is given to arousing students curiosity and interest. The presentation highly regards the psychology of learning. The subject matter is arranged according to the inductive method. Areas on which students can work on the solution of problems are also provided. In this textbook the topic is started with a very interesting introduction as follows:

> You may have wondered why birds are not killed instantly when they perch on a high-tension power line. If you were to hold one of these lines in your hand you would be killed at once. What is the difference? In your case the circuit is "closed" or, as we say, short-circuited so that a high voltage would force a current through your body to the earth. The bird, however, does not short-circuit the line. Both its feet are close together on the same line. There is only a slight voltage difference between these points on the line so that little or no current can pass through the bird's body.
>
> If you stick your finger into a lamp socket you will get a nasty shock and learn by experience that a house circuit can be unpleasant but not fatal. However, let us not be too certain of our conclusions because if you had been sitting in a bathtub full of water the effect would probably have been fatal. How can you explain these different effects? When you stand on an insulating floor the voltage of the house circuit (probably 110 to 120 volts) is unable to force much current through your body. But if you are immersed in soapy water in the bathtub the situation is quite different. The soapy water has a good many substances in solution that make it a good conductor of electricity. In other words there is now an easy path for the current to take, or, as we usually say, there is less resistance to the current. The current now passes through the

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1. Hogg, J.C., et. al., Chemistry, A Course for High Schools. New York: D. Van Nostrand Co., Inc., 1953

body because it can flow through the bath water to the metal bathtub, and thence along the metal drain pipe. The light-socket experiment can be exceedingly dangerous if performed in a bathtub. Don't try it!

Do All Liquids and Solutions Conduct Electricity?

Suppose the bathtub experiment had been tried in distilled water, or in a salt solution, or in a sugar solution, or, to give vent to a vivid imagination, in alcohol. Would there have been a risk of fatal accident? The answer is "Yes," in one case only but not in the other three." We have now reached the point where we must look for reasons so that the bathtub experiment makes sense. But first let us try the experiment on a laboratory scale using a variety of different solutions.

Then a set of experiments utilizing different solutions in the usual "battery-bulb-electrodes-in-beaker" apparatus are suggested. Then comes the major problem around which the whole topic is integrated. The problem is: Why do solutions of electrolytes conduct a current? To answer the problem, the following phenomena are discussed:

1. Conductivity of current.
2. Having two sets of properties.
3. Deviation from Rá'oults Law.

Then the theory of ionization is introduced as an explanation of these phenomena. (This is the inductive approach).

To discuss electrolysis, the textbook begins with electroplating of many familiar objects with silver, gold, or chrome, and explainshow this is done in industry. The electrotype is also discussed (This beginning is psychologically sound because it arouses students' interest by relating knowledge to things which they have experienced). Electrolysis of acids, bases and salts, with the numerous applications in industry, brings the topic to its end.

The advantages of such a presentation over the presentation used in the textbook of Iraq are:

1. Knowledge is made interesting by relating it to students experiences, to their need of security and to what they observe in their environment.

2. Knowledge is made useful, and applicable in students' lives. They can, for example, electroplate cheap articles with silver for home use or for personal use.

3. Scientific inductive thinking is facilitated because theories, generalizations and definitions are always mentioned after the concrete evidence for them is explained. It is always suggested that such evidence be acquired through experiments, that is, the experimental approach is stressed.

None of these aspects is recognized in the chemistry textbooks for the secondary school of Iraq.

However, it is necessary to note that even when the curriculum is organized logically, a resourceful teacher can follow a psychological plan, provided, on the one hand, he is allowed some freedom to improvise methods, activities and materials which suit his class, and on the other, he has a full grasp of the psychology of students and the psychology of learning, together with a sound training in effective teaching methods.

Such understanding of teaching methods and of the psychology of learning and of the students enables the teacher to capitalize on the students' sources of motivation and direct these liberated energies to the end that effective learning may result. Let us take for instance the topic on phosphorus. Instead of beginning with occurrence, properties, and preparation of phosphorus (which is a logical organization), a resourceful teacher can start this topic by a practical project on making matches. This project will serve as a spark which ignites students interest, hence learning will be facilitated and reinforced. This same project can also serve as a core around which the understanding of phosphorus, its properties, preparation, uses and compounds are unfolded meaningfully.

PART II

MODERN TRENDS

CHAPTER VI

MODERN TRENDS IN THE OBJECTIVES OF THE SECONDARY SCHOOL

Chapter II in the thesis desicussed the objectives of the secondary school in Iraq. There it was shown that those objectives were not adequate for a country committed to democratic ideals. The function of the secondary school in a democratic country is much more extensive.

Many statements of objectives exist in recent books on educatioh. It is the writer's opinion, however, that the objectives of the secondary school formulated by the National Association of Secondary School Principals in the United States of America are most pertinent for the secondary school in Iraq. These objectives are stated in terms of the basic needs of youth.

These same needs are imperative for the youth of Iraq. Therefore, it is the duty of the secondary school of Iraq to help youth meet these needs which are listed below:

> The Imperative Needs of Youth of Secondary School Age[1]
>
> Imperative Need Number 1 - All youth need to develop salable skills and those understandings and attitudes that make the worker an intelligent and productive participant in economic life. To this end most youth need supervised work experience as well as education in the skills and knowledge of their occupations.

Attention to this need is almost entirely lacking in the secondary school of Iraq. However, it is planned to

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1. National Association of Secondary School Principals, The Imperative Needs of Youth of Secondary-School Age. (Bulletin No.145) Washington, D.C. 1947. As reported in Bossing, N.L., Teaching in Secondary Schools. New York: Houghton Mifflin Co., 1952, p.25. The entire bulletin is devoted to an analysis of the ten imperative needs listed in this chapter.

open in Mosul, Baghdad and Basra, three vocational schools of the same standing as secondary schools.

> Imperative Need Number 2 - All youth need to develop and maintain good health and physical fitness.

See the critique applied to this same aspect in Iraq on p.15.

> Imperative Need Number 3 - All youth need to understand the rights and duties of a citizen of a democratic society and to be diligent and competent in the performance of their obligations as members of the community and citizensof the state and nation and of the world.

This need is almost completely neglected in the secondary schools of Iraq. See critique of social development of the students on p.11.

> Imperative Need Number 4 - All youth need to understand the significance of the family for the individual and society and the conditions conducive to successful family life.

Attention to this need is completely lacking in secondary schools of Iraq.

> Imperative Need Number 5 - All youth need to know how to purchase and use goods and services intelligently, understanding both the values received by the consumer and the economic consequences of their acts.

Such training in economic efficiency is also lacking in secondary schools of Iraq except for a single theoretical course in economics given only in the arts section of the preparatory school.

> Imperative Need Number 6 - All youth need to understand the methods of science, the influence of science on human life, and the main scientific facts concerning the nature of the world and of man.

Although this same objective is stated in the Ministry's syllabus, yet actual practice never leads to it. See the critique of the "scientific spirit", "logical thinking" and "experimental attitude" on p.17.

> Imperative Need Number 7 - All youth need opportunities to develop their capacities to appreciate beauty in literature, art, music and nature.

This need is not much cared for in the secondary schools of Iraq. See the critique of "aesthetic appreciation" on p.21.

> Imperative Need Number 8 - All youth need to be able to use their leisure time well and to budget it wisely, balancing activities that yield satisfactions to the individual with those that are socially useful.

This kind of education is also lacking in the secondary schools of Iraq. Students are left totally without guidance in this respect.

> Imperative Need Number 9 - All youth need to develop respect for other persons, to grow in their respect for ethical values and principles and to be able to live and work cooperatively with others.

Again, this is a need which is not adequately met in Iraq. See the critique of "the character aspect" on p.7.

> Imperative Need Number 10 - All youth need to grow in their ability to think rationally, to express their thoughts clearly and to read and listen with understanding.

Again attention to this need is not adequate in Iraq. See the critique of the "scientific spirit, "logical thinking" and "experimental attitude" on p.17.

CHAPTER VII

MODERN TRENDS IN THE OBJECTIVES OF CHEMISTRY TEACHING.[1]

Objectives of chemistry teaching in the secondary school of Iraq, as discussed in chapter III in the thesis are not adequate. Further, actual practice in schools does not lead to them.

It is the purpose of this chapter to show what are the modern objectives of chemistry teaching in the secondary school.

To be effective, these modern objectives must contribute toward attaining the over-all objectives of the secondary school which are discussed in chapter VI. They, also, should coincide with the over-all aim of education which should be the total growth of the student as Dewey has said.

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1. The material for this chapter has been collected and adapted from the following references:

(1) National Society for the Study of Education, Science Education in American Schools. 46th Yearbook, Part I, Chicago: University of Chicago Press, 1947, pp 19-41.

(2) National Society for the Study of Education, A Program for Teaching Science. 31st Yearbook, Part I, Illinois: Public School Publishing Co., 1932, pp. 256-261.

(3) Heis, E.D., et.al., Modern Science Teaching. New York: Macmillan Co., 1951, pp. 21-41.

(4) Frank, J.O., The Teaching of High School Chemistry. Oshkosh, Wis.: J.O. Frank and Sons, 1932, pp. 29-46.

(5) Hoff, A.G., Secondary School Science Teaching. Philadelphia: The Blakiston Co., 1947, pp.47-49.

(6) Day, J.H., "Why Study Chemistry?" , Journal of Chemical Education, March 1951, p.154.

When considering the objectives of chemistry teaching, we should not think merely in terms of how much subject matter can be memorized by the students. Subject matter is not an end in itself. It is a means to an end. The end is the growth of the student in desirable directions. Therefore, when considering the objectives of chemistry teaching we should think in terms of the students, that is, in terms of the desirable changes to be brought about in the thinking, attitudes, interests, appreciations and behavior of the students.

Many educators agree that learning is the process of changing behavior through appropriate experience situations. These changes in behavior patterns should be such as to insure that the learner will acquire those general types of behavior competencies necessary for effective living in his contemporary environment, and which will give promise of increased effectiveness, as the demand upon him becomes greater, in the larger activities of an adult citizen.

The recent trends in objectives of science teaching all seem to be directed toward this more functional point of view.

However, if chemistry teaching is to really become a useful agency through which a student's growth is furthered; through which his ability to adjust effectively to the problems of living is developed; then, this point of view, and the method by which it may be achieved, must become a part of the day-to-day work in the classroom. It must permeate the thinking of the teacher as plans for lessons are prepared. Otherwise, any set of objectives, however valuable they may be, would remain only a set of paper goals.

The following objectives[1] should be considered as general directions of growth. The activities and experiences of each chemistry period should contribute to the gradual growth of the student in at least some of these directions. The objectives are:

1. Functional Understanding of Facts, Concepts and Principles of Chemistry:

Chemistry plays an important role in daily life, as in drugs, foods, consumers' products, home commonplace processes such as cleaning and removing of stains, photography, paints, etc.

All industries are using chemistry to an ever-increasing degree. These industrial advancements have significant implications for the individual's life, society's life and for national affairs. Therefore, a reasonable understanding of chemistry seems to be necessary for the cultivation of a well adjusted and highly enlightened citizen.

To be functional, facts of chemistry taught to the students should be of vital value to their lives and should help them adjust more effectively to the natural and to the social environment. Things studied in chemistry should have

1. These objectives of science teaching were originally suggested by the National Society for the Study of Education in the 46th Yearbook (Part I). In this chapter, they have been adopted to fit chemistry teaching.

direct or potential application in the students' lives. Such topics as foods, vitamins, hormons, cosmetics, textiles, fuels, petroleum, lubricants, inks, dyes, soil, atomic energy and its peace-time uses are examples of functional understandings necessary for the secondary school students. The unique value of a course in chemistry is that it is the only course in which students learn about the nature, structure, and chemical changes of the matter of which their environment is composed. Such knowledge is of prime importance in the development of a sound understanding of nature. It also helps to eliminate whatever superstitions students may have about natural phenomena.

Functional facts of chemistry are important, but how to put these facts together into meaningful ideas or generalizations is even more important. Generalizations, when functionally understood can be applied to new problems and situations, thus they help the students meet life situations effectively.

To be truly functional, facts, concepts, and laws of chemistry must be built from experience. To memorize them from printed material will not enable the students to integrate them and use them in the solution of their day-to-day problems.

2. Instrumental Skills — such as ability:

a. To read chemistry content with understanding, and to evaluate news, articles and popular writings on chemical developments.[1]

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1. How to use popular or semi-popular articles on science to help students acquire a scientific reasoning and understanding is explained in the following book: Science Reasoning and Understanding. Dubuque, Iowa, WM.C. Brown Co., 1954.

b. To perform experiments with chemical equipment and to do simple research work in chemistry.

c. To understand graphs, tables, charts, etc.

d. To make accurate measurements, observations, readings, titrations, etc.

e. To make correct interpretations.

f. To form independent judgments.

g. To evaluate.

<u>3. Problem-Solving Skills</u> - as shown by ability:

a. To locate and define a problem.

b. To collect data (relevant to the problem) systematically.

c. To generalize from facts (i.e., to formulate a hypothesis).

d. To test these generalizations by experimental or other means.

e. To draw conclusions.

f. To apply these conclusions to new situations.

Teaching for the development of the ability to solve problems has recently received considerable emphasis as a desirable objective of the secondary school. This fact is clearly expressed in the 46th Yearbook of the National Society for the Study of Education [1] as follows:

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1. National Society For The Study of Education. 46th Yearbook, Part I, <u>op.cit</u>. p. 189 .

> The development of use of the scientific method of problem-solving and the inculcation of scientific attitudes transends in importance other objectives in science instruction.

No area in the secondary school curriculum provides experiences in thinking more than science.

However, no one ever becomes a better problem solver by reading about chemical facts and principles in books, or by being in a laboratory full of bottles, test tubes, and chemicals, or even by observing the teacher doing chemical miracles.

If students are to become better problem solvers, they have to solve some problems that have meaning and significance to them. They should solve such problems in a truly scientific spirit, following the steps of the scientific method of problem-solving. By using this process over and over, students will become convinced that this process of solving problems is good because it produces reliable results. Therefore, they will have confidence in it and use it to solve their daily problems.

4. Scientific Attitudes - as shown by ability:

a. To view facts objectively.

b. To suspend judgment until facts are secured.

c. To revise one's opinion if the evidence warrants.

d. To be open-minded.

e. To have conviction in the universality of the cause-and-effect relationships.

f. To have a spirit of inquiry.

To develop such attitudes, teachers must emphasize them and guide students to practice them as they are solving problems, so that eventually these attitudes will become a part of the students' mental equipment. Teachers must plan to develop these attitudes just as they plan to teach facts and principles.

5. Appreciations - such as:

a. Appreciation of the contributions of chemists and the implications of their research and findings to the well-being of individuals, society, and to national affairs.

b. Appreciation of the contribution of the scientific method.

c. Appreciations of nature's laws and phenomena.

These appreciations may grow out of experiences in nature, in the factories, and in the laboratories. Out of such experiences, each student may develop for himself an appreciation that fits himself.

6. Interests - such as:

a. Interest in some phase of chemistry as a recreational activity or hobby which may be used to enjoy spare time.

b. Interest in reading about chemistry.

c. Interest in chemistry as a field for a vocation.

The above objectives of chemistry teaching are the general objectives toward which every unit in chemistry should contribute. No one unit will make contributions to the entire extent of any one of these general objectives, but each unit will achieve some growth in these areas.

Subject matter, methods, and experiences provided for students in a chemistry course in the secondary school should be selected and organized in terms of these objectives. This is a more sound procedure than to impose a rigid curriculum of the formal type, then attribute to it a whole gamut of objectives which could not possibly be achieved in a formal, rigid setting.

Appreciations, interests, attitudes and problem-solving skills are far more important than mere facts. Actually, they are the more permanent phases of learning which remain with the individual long after specific facts and knowledge have been forgotten. This implies that greater emphasis in our teaching procedures should be placed on these areas of students' growth. If the future citizens who are our students now will ultimately be skillful in solving their personal problems and their nation's problems, if they will ultimately have a scientific attitude and approach to the baffling problems of their society, if they will ultimately be willing to face facts in the spirit of science instead of being swayed by prejudice, then we are achieving the true and principal objectives of chemistry teaching in our secondary schools.

CHAPTER VIII

MODERN TRENDS IN CHEMISTRY TEACHING

A. <u>Purpose of the Chapter</u>

Chapter IV shows that actual practice of chemistry teachers in Iraq accomplishes very little, since the methods followed aim merely at imparting information to students in a finished encyclopedic form. Modern objectives of chemistry teaching as discussed in chapter VII can not possibly be achieved through such exclusively formal instruction.

The main purpose of this chapter is to explain those aspects of methods and practices which help to implement the modern objectives of chemistry. The necessary psychological and educational considerations which show the desirability of the practices suggested in this chapter will be also provided.

B. <u>What Is Teaching</u> ?

Teaching can be defined simply as follows:

<u>It is the act of helping someone to learn</u>[1]

Modern education maintains that learning is an active process on the part of the learner. The role of the teacher is that of a guide. The teacher guides the process of the student's learning so that the learning that results is of the right kind. <u>This conception of the teacher's role in guiding learning</u> implies that the teacher has a clear objective — that he understands what learning he is trying to help the students

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1. This definition is a modified form of the one proposed by: Reeder, W.G. <u>A First Course in Education</u>, New York, Macmillan Co., 1943.

develop.

The conception that learning is an active process on the part of the learner implies that the learner must himself be involved in learning. Since each learner is different from the next, it is apparent that the teacher cannot be effectively guided by a series of specific rules, because the specific steps that might help to guide one student would not necessarily be appropriate with another. Hence it is essential for the teacher to understand and be able to utilize general concepts and principles of learning rather than to follow some collection of specific teaching rules. For example, learning is often facilitated when:

1. Students have a clear-cut understanding of goals.
2. The teacher recognizes individual differences.
3. Learning experiences are related to pupils' lives.
4. Things are taught the way they will be used, i.e., things are learned in a life-like setting as in a field trip.
5. Students need to find out something.
6. The student can keep track of his progress. Recognition of ones success in learning serves as a powerful motivating force.
7. The learner is working for himself and not the teacher.
8. Praise is used instead of blame.
9. Subject matter is organized by wholes. Things will be more meaningful when recognized in larger contexts.

10. Social process is tied to learning. When a group attempts to solve a problem, the learning is given a social reinforcement.
11. Students help plan the goals. Self-determined goals are powerful motivating forces.
12. Motivation is intrinsic rather than extrinsic.
13. The subject matter is within the range of challenge.
14. The subject matter is needed by the learner.

Besides the above-mentioned general principles of effective learning, the teacher needs to know some of the methods and materials of chemistry teaching through which learning goes on economically and effectively. These methods and materials will be explained in the following sections of this study.

A summary of the foregoing argument shows that teaching is the act of guiding a student to learn. In order that the teacher be able to guide the student's learning, he should have a clear understanding of objectives, of principles of learning, and of effective methods and materials of teaching.

C. Aspects of Teaching that Help to Implement the Objectives of Chemistry.

1. Role of Experience in Learning.

In the previous chapter, the modern objectives of chemistry teaching were considered as the desirable aspects of the student's growth which chemistry teaching can foster and promote. These desirable aspects of the student's growth are mainly the following:

a. Growth of the student's understanding of and ability to use chemical facts, principles and products for his well-being and for the well-being of his society.

b. Growth of the student's skill in using the scientific method to solve his personal and social problems.

c. Growth of the student's scientific attitudes and appreciations and interests.

Such growth would enable the student to behave on an increasingly mature level. In other words, those understandings, abilities, skills, attitudes, interests, and appreciations will be the dynamic forces that change the student's behavior to desirable ends.

However, this <u>change of behavior comes only through the individual's experience</u>.

Although this fact has been previously mentioned in many places in this thesis, yet the writer feels that it needs more elaboration.

An example of how experience helps to bring about a real change in behavior; a successful adjustment to the facts and the principles operating in the environment is the little child who takes something from a hot stove. He realizes by experience that things taken from a hot stove may burn the hand. Accordingly, he will behave more intelligently when dealing with the pan-on-the-hot-stove situation. This experience has brought about a functional understanding on the child's part; an understanding which will help him to adjust to the environment more intelligently and successfully.

In other words, this understanding has functioned to change behavior to a more mature level. Similarly, a student who, after having many experiences in the laboratory or elsewhere about the values of different kinds of foods and their effect on growth and health, will show wiser choices of foods which will promote his health and well-being. Another example is the student who has had laboratory experiences about textiles, how to identify their different kinds, how to judge their qualities, how to determine their wearing ability, and so forth, Such a student will behave intelligently when purchasing clothes for himself.

The central responsibility of the teacher is, therefore, to make certain appropriate and rich experiences available to his students. These experiences should be carefully selected and organized so that they may help to bring about desirable changes in the behavior of the students. However, it is important to note that an experience is a private matter; it is the student's own experience, not the objective situation as it is perceived by someone else, that changes him.

As mentioned on page 14, <u>the basis of all understanding, thinking, and attitude-formation is real experience</u>.

McKown and Roberts[1] add the following argument to

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1. McKown, H.C., and Roberts, A.B., <u>Audio-Visual Aids to Instruction</u>. New York: McGraw-Hill Book Co., Inc., 1949, p.36.

the above mentioned principle. They say:

> Intellectual activity depends, directly or indirectly, upon experiences that come through (the senses). Even the internal reactions, the higher types of cerebrations often designated by the general term original thinking, and including such mental activities as concentration, reflection, conception, imagination, association, discrimination, and recollection have their basis in sensory experience because the mind must have something to think about or play with, like the stomach, it works on what it is fed. This feeding comes through the senses.

It is obvious, therefore, that sensory experience is the foundation of intellectual activity and that real and effective learning comes through the senses. Sensory experiences are not only essential to better understanding, but the extent and success of the student's future learning and mental activity depends on them. The greater the number and variety of these experiences, the better able the student will be to comprehend and interpret other new ideas as they are presented to him later. In the words of Professor Hubbard (of the Education Department at the American University of Beirut), "the broader the base of perceptual understandings, the higher we can build the structure of conceptual understanding."

Heiss,[1] McKown and Roberts,[2] and the 48th Yearbook

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1. Heiss, E.D. et al., Modern Science Teaching, New York: Macmillan Co., 1950, p. 281.

2. McKown, H.C., and Roberts, A.B., op. cit., p. 37.

of the National Society for the Study of Education,[1] all agree that human beings derive their experiences mainly from three sources, namely:

a. Direct sensory contact (or first hand experience). Laboratory work, demonstrations, practical projects, field trips to factories, mines and other places of chemical interest, community surveys are examples of this kind of experience.

b. Vicarious representation of realities, objects, and phenomena such as motion picture films, filmstrips, exhibits, models, pictures, slides, etc.

c. Spoken or written words or symbols.

The third of these sources is of little value unless proper sensory experience is provided to serve as a basis for interpreting the oral or written word. The term "chemical action" will not have much meaning to a person who has never seen precipitates form or colors change or who has never heard the sizzling in a test tube, that is, who has not experienced directly a large variety of chemical action. As mentioned on p. 14, words are abstractions which represent or stand for objects, qualities or relationships. Therefore, if words are to be really understood, students should have experience with the real thihgs which

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1. National Society for the Study of Education, Audio-Visual Materials of Instruction, 48th Yearbook, Part I, Chicago: University of Chicago Press, 1949, p. 75.

words stand for. Only when words actually represent things which the student has experienced can he learn from them. Therefore, first-hand sensory experience must come either before or simultaneously with words, if the latter are to be meaningful.

However, we don't mean to deny the effectiveness of "verbal symbols" as teaching tools — as a medium through which ideas are communicated. In fact ideational thinking cannot be made without words. Words can give us mental freedom from concrete experience, for thought, interpretation, generalizations, and drawing of conclusions. Our experiences are not communicable unless we attach words to them.[1]

A great deal of meaning can be crystalized in a single sentence, a sentence that summarizes a group of related experiences. However, teachers have to be very attentive to the fact that words are useful and meaningful to the extent that they grow out of concrete experiences. Words are also communicative depending on the degree of commonness of experience between the conveyer and the conveyee. Therefore, words should not be denied their role as effective teaching tools, but they are effective only when the experiences they compactly embody are unfolded

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1. For the complete consideration of this point see Dale, E., Audoi-Visual Methods in Teaching, New York, Dryden Press, 1954, pp. 37-50.

to the learner through the use of other tools. On the other hand, mere contact with an object or a process does not guarantee learning. "Fractional crystalization," for example, needs to be "explained" by words while the process is taking place. It is also definitely clear that the words used in connection with "fractional crystalization" are most meaningful when the process is actually being experienced by the learners.

The relationship between words and things or "experiences" is a complex one. We do not want to weaken the bonds but to strengthen them. We must help people to see more meaning in words, to "understand" them better, to use them more correctly.

The foregoing argument of the role of first-hand direct experiences in the effectiveness and meaningfulness of student's learning makes it clear that we should not rely completely on the "read-write, listen-speak" procedures in teaching of chemistry. It is essential that students be provided experiences with chemicals, apparatus, chemical reactions, and the properties, uses, and applications of chemistry in real life, in the home, in industry, in agriculture and in medicine. We should not be content with speaking to students about chemical facts, principles and applications, or simply make them read about such facts in their textbooks. Facts, concepts, and laws of chemistry should be built from experiences with chemicals, actual specimens, reactions, properties, products and applications. When teaching facts, concepts and laws we always need to connect the abstract to the concrete; the conception to the perception.

It is a grave mistake to act on the fallacy that learning may arise out of reading or hearing divorced from personal experience. As mentioned above (p. 15), an exclusive dependence on the textbook when the students lack a proper background of perceptual understanding results in verbalism, lack of ability to see such verbally acquired material in real-life situations, and the habit of uncritically accepting the formulations of other people. Further, such learning is a waste of students' time and effort, is easily forgotten, and will fail to bring about any desirable change in students' behavior.

If learning is to be effective, meaningful, and integrated in the life of the students, then we have to provide them with experiences; we have to make them work with the apparatus and materials of chemistry; we need to make them engage in activities and have experiences. Therefore, students should be given more and more experiences through such procedures as laboratory work, demonstrations, practical projects, field trips and the like.

2. Teaching of Facts and Concepts[1]

As has been already pointed out, the facts of chemistry should be taught first-hand in the laboratory, in demonstrations, in the factory, etc.

Facts should be seen and handled directly. The books are not chemistry, but literature. When the sole experience of the student is reading about these facts in the textbook, then certainly he will come out with distorted and hazy ideas. The statement that chlorine is more active than bromine and bromine than iodine is a lifeless statement to one who has no experience with these substances. However, if the action of chlorine on salts of bromine, action of bromine on salts of iodine is experienced by the student the statement becomes full with meaning.

It is important that the facts of chemistry are also tied in firmly with the daily experience of students. Facts taught to students should be of immediate or potential benefit to them.

Facts should be taught for either their utilitarian value or for their intellectual appeal.

Concepts are syntheses of facts, and they, therefore, should be built from experience with the facts that constitute those concepts. For example, the concept that matter is made up of small particles can be built from experience in the diffusion of colors in water, diffusion of perfumes in air, evaporation, etc.

1. Many of the ideas here are derived from: Twiss, G.R., Principles of Science Teaching, New York, Macmillan Co., 1938, p. 358.

3. Teaching of Laws[1]

Most teachers of chemistry ask the students to state the law as given in the textbook, such as the law of definite proportions or multiple proportions. Then, evidence for the correctness of the law is stated. Teachers then give the students a set of exercises which they are expected to solve or explain by using the law. This exclusively deductive method shuts up the mind, takes off the sharp edge of curiosity, and inhibits reflective and inductive thinking at the very beginning.

To have the students memorize the principles first and afterwards apply them to exercises is not a correct way of teaching. Twiss[2] says that, " Laws are merely convenient condensed statements under which like facts and like relations between facts are summed up".

To be able to comprehend the law, Twiss[3] suggests that the students need to know at least a considerable portion of facts for which the law is a generalization. It is highly recommended, of course, that the student have laboratory experience with many of the facts which the law generalizes. If such experiences cannot be made available, it is very necessary for the teacher to emphasize the fact that such information has been obtained through experiments. In the case of Boyle's law for instance, many experiments can be done with the usual

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1. Ibid., p.22.
2. Ibid., p.358.
3. Ibid.

apparatus. Numerical values of pressure and volume should be recorded. A skillful discussion of these numerical results will enable the students themselves to recognize the relationship that exists and to draw the possible generalisation and formulate it with their own words. This is the inductive approach which leads to a full grasp of the law.

After the law is abstracted from experimental facts, it should be applied to new situations. The critical element here is the ability to use the new knowledge; to be able to con-control phenomena through the use of the law or to be able to identify it under new conditions .

4. Teaching for Improvement in Thinking, Skill in Problem Solving, Development of Scientific Attitudes, Interests and Appreciations .

Since effective learning which helps to bring about a change in behavior is that which is carried through the learner's experience, therefore, skill in problem solving will not be developed except through the actual solution of problem. Scientific attitudes, appreciations and interests will not be developed unless the learner is given opportunity to investigate and experiment and to apply the results

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1. Many of the ideas in this section are derived from: Richardson, J.S., and Cahoon, G.P., *Methods and Materials for Teaching General and Physical Science.* New York: McGraw Hill Book Co., 1951, pp. 66-82.

of his investigation in matters that concern him, i.e. in his own life. Only then his scientific attitudes, his appreciation of an interest in chemistry will grow.

Teaching for reflective thinking has recently received considerable emphasis as a desirable objective in science teaching. Many educators stress the need for improvement in thinking; improvement in the ability to solve problems; and concomitant attitudes, interests and appreciations . These aspects are considered as more important than achievement in subject matter. In a democracy, where citizens are called upon to participate in solving community and national as well as personal problems, everyone should be able to think critically about problems and their solutions. No area in the secondary school curriculum provides experiences in thinking more than science . " Here the very terms suggest various aspects of thinking - scientific method, experiment, control, test, verification, conclusion, and authority. "[1]

However, reflective thinking, does not emerge as an automatic outcome of participating in the usual science corses. To work in a laboratory does not guarantee generalized outcomes of reflective thinking, though it may have excellent possibilities of helping to make progress toward this goal.

Many students' experiences in the science laboratory may be quite perfunctory and devoid of thinking . The blind following of directions and filling in of blanks for reports

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1. Ibid., p.67.

is not likely to be good experience in critical thinking. A demonstration performed by a teacher who points out what is happening and indicates the conclusion which should be drawn, or how it illustrates a particular principle may provide little experience in thinking. This limitation need not exist.

Richardson and Cahoon[1] say that :

> Work with apparatus and materials such as demonstrations, laboratory work, or projects has some obvious possibilities for experience in thinking. Here ... something more than memory of facts or statements of principles from the printed page should be developed. A wide variety of processes relating directly or indirectly to critical thinking comes into play with different kinds of work with apparatus. Making accurate observation, devising apparatus, predicting, remembering, applying facts and principles to new situations, interpreting observations, formulating and testing hypotheses, finding the reasons for results, planning controls, withholding judgments, being tolerant — these are some of the experiences which students may have.

However, students are likely to have these experiences in thinking only when the teacher plans deliberately to provide them with opportunities of the above-mentioned sort.

Teaching for thinking is largely a matter of utilizing the usual teaching procedures appropriately as the teacher goes about teaching scientific concepts, facts, and principles. If mastery of facts is an important course outcome, its realization may be furthered by appropriate experiences in thinking.

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1. Ibid., p. 67.

Teaching for thinking can be achieved through the following practices:

a. Using the Laboratory in Teaching for Thinking

If students are allowed to choose and set up their own laboratory problems and to participate in planning the procedures for solving certain proposed problems, there is abundant opportunity for thinking. The clear definition of the problem and statement of the hypothesis to be tested are very important phases of thinking. The use of "controls", is an essential technique of the scientific method. Where students are encouraged to set up and try out problems involving controls, these do provide worthwhile experiences in thinking. Since the value of problem-solving through laboratory work in the school does not lie in the factual knowledge that may result from it but in the attitudes and habits of reflective thinking it encourages and in the understanding it gives of how the knowledge of sicence gained by the student from description was attained in the first place, all such experiences relating to thinking are desirable.

It is regrettable that, in general, the chief aim of laboratory work has been the verification of facts and principles learned in the classroom and from the textbook. Experimentation comes after exhaustive reading and classroom discussion. The student already knows the required answer. He strives to squeeze his own results and conclusions into line with the formulations of the textbook. This procedure produces no scientific thinking and attitude and no skill in problem-solving, but makes the laboratory work a boring job. Or even when laboratory work precedes class discussion, it is usually a kind of imitation rather than critical thinking. Experiments which students perform amount to little more than "cookbook" manipulations. This also does not train in thinking, nor in problem solving. Laboratory work need not be of the cookbook type but rather it should be simple experiments which the student devises himself, no matter how crude; observations which he makes and records himself, no matter how inaccurate and unreliable; conclusions which he formulates himself, no matter how fallacious. This is his own ability to think being exercised. It is the growing-pains of his intellect, his real education.

b. Using Demonstrations for Teaching for Thinking

Instead of being told about the "why" of every single step followed in a demonstration and the conclusion to be drawn from it, students should be made to think about the "why", to try to do the interpretation and draw the conclusions themselves.

Demonstrations should be used mainly in problematic situations; problems that demand the finding of certain facts, the discovery of causes and effects. The practice of using demonstrations to "make clear" those facts that have already been read in books will not provide any opportunity for thinking.

c. Teaching for Thinking in the Classroom[1]

Classroom practices can contribute to student's understanding of and ability to use the scientific method of thinking. The following aspects are suggested:

(1) The student can be made to recognize the scientific method of thinking by pointing out the relationship between a specific fact and the method of investigation which has led to its discovery. Dr. Conant[2] brilliantly describes the use of case histories for teaching science and the scientific method. For instance, the teacher can spend some time on the changing concept of hydrogen from the four elements of the ancients, through the phlogiston of the middle ages, on to Cavendish discovery of the compound nature of water, and especially tracing the rapidly changing twentieth century concept of it — its atomic structure, its reactions and the hydrogen isotopes, down to the radioactive hydrogen of today.

The possibility of showing students the effect of rigorous application of the scientific method and its power will make students have more confidence in it.

(2) Teachers presentation should follow an inductive approach as much as possible. Both induction and deduction are necessary, but we have to begin with induction. For

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1. Some of the ideas in this section are derived from: Kieffer, W.F., "The Place of the Scientific Method in the First Course in Chemistry." Journal of Chemical Education. Vol. 31, June 1951, pp. 300-303.
2. Conant, J.B., On Understanding Science. New Haven : Yale University Press, 1947.

example, to present to the students Dalton's Atomic Theory, then suggest that they now turn their attention to the evidence is a wrong presentation. Such a presentation will shut the minds of the students; will not allow them any apportunity to think. Therefore, the opposite should be done, that is, we should begin with observed phenomena which will lead to the theory. The theory is then understood as a way of explaining the observed phenomena. Similarly, simple weight ratios should evolve into the law of definite proportions. Another example of the proper way to present the ionization concept is cited on p. 65-67 in this thesis.

(3.) Current news articles and popular and semi-popular writings which attempt to explain science to the layman, can be used by the class when they contain valuable material. In order that such articles may develop thinking they should be used according to the following method:[1]

(1) Have students read a description as to how one scientific problem was solved and give examples of inductive steps, deductive steps, and hypotheses that were formed. The student is asked to make comparisons with other problems studied both as to purpose and general method. He is asked to give his opinion as to what would have happened to the experiment in its early stages had certain errors crept into the investigation.

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1. This is discussed extensively in the following book: Science Reasoning and Understanding. Dubuque, Iowa: WM. C. Brown Co., 1954, pp.22-54.

(ii) Have a problem statement presented to the class, and let them work on it in the laboratory and write their arguments to support their hypotheses.

(iii) Construct many questions on an article and let students write down answers to them deriving information on them from the article.

4. The textbook material also can help the student to think if it follows an inductive organization, and if it incorporates many problems for the student to solve, either by utilizing past experience or by working in the laboratory.

D. Psychological And Educational Factors Which Necessitate Learning Through Experience:

The forgoing argument about the role of experience in learning makes it clear that learning cannot be meaningful unless it is carried through the students experience. However, if the desirability of learning through first-hand experiences in the laboratory, around the demonstration table, in the factory or elsewhere needs further supporting arguments or reasons, these may be developed as follows:[1]

1. Learning by doing:

This is a maxim of modern education which follows an important principle in the psychology of learning. Materials, concepts, devices, applications and generalizations of chemistry are new to the beginner. They can be made meaningful by actual use.

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1. Most of the ideas in this section are derived from: Richardson, J.S., and Cahoon, G.P. Methods And Materials For Teaching General And Physical Science. New York: McGraw-Hill Book Co., Inc., 1951, pp.6-8.

2. Critical thinking:

Excellent opportunities for student experience in reflective thinking can be provided through laboratory work and demonstrations. Problems related to the "how", "why" and "what would happen if" type of questions can always be raised in connection with demostrations and laboratory experiments. Thinking is also involved in the planning of experiments, in the interpretation of results, and in generalizations which students may draw on the basis of the outcomes.

3. Initiative, Resourcefulness, Cooperation:

Modern education is concerned about the total development of the whole personality of the individual. Initiative, resourcefulness and cooperation are all important aspects of the individual's personality which can be developed through good utilization of laboratory experiments, demonstrations, field trips, individual or group projects and the like. Initiative and resourcefulness of students are developed when they participate in planning with the teacher the activities to be carried out in a laboratory, when they, either as individuals or as small groups, work on projects such as constructing a nuclear reactor model, an electrolytic cell, an apparatus for estimating the degree of ionization of electrolytes, etc. Initiative and resourcefulness are also developed when students work on problems of their own chooing to meet a need or to satisfy an interest.

Cooperation can be developed in students when they work in small groups on the same experiments. It can also be developed in the taking of field trips. When students participate in planning, in arranging for details, and in determining the particular experiences to be secured in the field trip, then there is ample opportunity for developing cooperation. Cooperation can also be developed through students' participation in collecting materials for exhibits, in planning for them and in setting them up.

4. Individual Differences:

Modern education gives attention to individual differences in needs, interests, problems and abilities. Such differences cannot be possibly catered to when "mastery-of-the-text" is the sole method. However, when laboratory work, demonstrations, projects, field trips and exhibits are used, then there are many opportunities to care for these differences. Students, then, can go on their own rates. Special help can be provided to each one of the students. Teachers can capitalize on whatever interests or skills the students may have to further their interest in and understanding of chemistry. Students may have such interests as photography, machinery, electricity, radio or painting. These interests can be discovered and encouraged in connection with activities involved in demonstrations, laboratory work, exhibits, and projects.

5. Variety and Motivation:

The chemistry teacher has a wide range of activities and procedures which would add interest and vitality to students' learning. Monotony in the chemistry classroom can be eliminated by such devices as dramatic demonstrations, experience in problem-solving and critical thinking,films, filmstrips, exhibits, and field trips. Ingenuity and planning prevents the chmistry teaching from being dull. Interest is mantained throughout the year if practical experiments are interwoven with other experiences in the regular course of instruction. Such experiments as testing foods for constituents and adulterants, dying cloth; analizing fabrics, testing soil, preparing cosmetics, testing fuels, testing the water supply for the salts dissolved in it, developing pictures, or making plastics, not only create interest, but help bridge the gap between what is studied at school and what the student actually meets and needs in life.

6. Participation:

It has been maintained at the beginning of this chapter that learning is an active process on the part of the learner. Therefore a student's active participation is essential if effective learning is to be expected. When a student participates in setting up goals, in determining activities, in taking responsibilities, in performing experiments, in doing observations and in discussion, then he will learn much more effectively than when he is a passive recipient of the information which is being poured into his head by the teacher. The concomitant learnings such as learning to cooperate, to plan, to be original and resourceful which result from the student's participation are sometimes greater in value than the factual knowledge which he gets. What a student gets out of a learning situation is directly proportional to the amount of participation that he has put in that situation. Laboratory work, demonstrations, exhibits, field trips, bulletin boards, etc., have obvious opportunities for student participation.

Participation can be in doing as in performing experiments, collecting specimens, minerals, rocks etc. It can also be in observing as in demonstrations, or it can even be on a mental level as participation in thinking, and group discussion.

PART III

MODERN METHODS, MATERIALS AND CONTENT

INTRODUCTION TO CHAPTERS IX AND X.

A. The teacher and the learning process:

The teacher can have a tremendous influence on the students' learning. He is the key figure in the learning process. The old concept of the teacher as a complement to the textbook is no longer true. The newer concept depicts the teacher as the architect of the students' learning experiences. He plans the type of learning environment in which students have the kind of experience they need, as realistic and meaningful as is feasible or possible..

Essential to any learning is interest-wanting to learn. An essential part of teaching is to motivate interest. Once genuinely motivated, the students will participate actively in learning activities. When the students really become interested, the learning that takes place provides its own thrill, provides motivation for further effort and becomes the origin of new interests. This kind of motivation is called intrinsic, and is highly recommended by modern education for effective learning.

After the students are motivated, the teacher's task then, is to provide them with experiences (both direct and vicarious), and to guide them in order that the required learning may result. To design such experiences, the teacher needs a wide variety of methods and materials. These methods will be discussed in chapter IX, and these materials will be discussed in chapter X.

1. How to Motivate the Students?

a. The teacher can motivate the students by making them see the connection between the learning problem and some of their important needs or interests. Chemical facts and principles have many applications in matters that concern the ordinary student. For instance, students may want to know how to get, prepare and use water softeners (This is especially true in Tallafar district in Iraq and in other places where water is not soft), ink removers, special kinds of cosmetics or storage batteries. They may want to know how to restore silver to original luster; whether coffee has been adulterated; how to know the wearing ability of wool, cotton and rayon; what constitutes good tooth powder, etc. A competent teacher can adapt his presentation; he can start with some of the concerns, needs or interests of his students and tie these concerns needs or interests to chemical facts and principles whenever that is possible.

b. Another method of motivating students is to tie learning to the students' own experiences. For example, the teacher who teaches sulfur to students in Mosul, should tie this topic to the students' experience with the sulfur springs in the suburbs of Mosul. The teacher can actually take his students to these springs. Reagents should be taken in such a trip. Many interesting experiments can be done with the water of the springs which is saturated with H_2S and various kinds of sulfides. Such a procedure will raise students' in this part may furnish direct purposeful experiences, as in the case of group and individual projects, laboratory work, field trips, and demonstrations where the students experience directly the actual objects, phenomena and processes. Members of the chemistry class who develop their own formula for tooth powder and work in the laboratory to prepare some for their own use, illustrate how direct experiences are provided by using the laboratory method. Because the individual learns best through his sensory channels, such learning is usually the most natural. The role of direct experiences in effective learning has been fully explained on pp. 84-92.

The importance of this type of learning makes it an obligation of the school to furnish as many opportunities as possible for direct sensing.

However, although direct experience is most educative, sometimes it is not, and often, too, it is neither desirable nor possible for the school to provide it for the students. In many cases vicarious experiences[1] are necessary because of the following factors:

a. Sometimes <u>danger</u> and <u>harm</u> interfere with direct experience. It is certainly not desirable to experience directly an atomic bomb explosion, the effect of drugs on internal organs, or the effect of a prolonged exposure to radio-

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1. By vicarious experience the writer means all the experience with the representations of objects, realities, phenomena and processes. Experience obtained through models, exibits motion pictures, television, filmstrips, slides, pictures, charts and diagrams illustrate this type of experiences.

active substances, etc. Yet it is desirable to have vicarious experiences with them through such devices as motion pictures, slides, still pictures, etc.

b. Time, expense, and distance may also interfere with direct experience. No school can afford to give its students a direct experience with everything that they may need to know about, such as atomic plants, far away factories, mines, etc. In such cases, although experience with representations may not be so valuable as direct experience, it is helpful because it is based on faithful reproduction of these items. Motion pictures, photographs, stereographs and models, are surprisingly effective. They also save time and expense and enable us to get at the inaccessible.

c. There are certain objects and phenomena where a reproduction is very necessary to illustrate the original, when the original is:

(1) Too complex such as a complicated petroleum refinery. The unseen detailed parts make it difficult for the student to understand how it works. A simplified diagram of it will serve to make the basic structure and work of the refinery clear and comprehendable.

(2) Too big such as a huge cyclotron or a petroleum field. A model of it enables students to see the parts in their proper relationships.

(3) Too small such as molecules. Models of them will help students to understand their structure.

(4) Too untimely to be successfully experienced directly such as some broadcasts which are pertinent to classroom study. They can be recorded and reproduced.

In short it is impossible for the school to bring the students into direct contact with all aspects of chemistry which they need to know. Consequently vicarious experiences are a necessity.

Both direct and vicarious experiences may appeal to senses other than the senses of seeing and hearing. They are more concrete and less symbolic then the printed words.

For the purposes of this thesis, whenever the term audio-visual methods and materials is used, it means to include both direct and vicarious types of experience. Although these methods and materials involve senses other than seeing and hearing, yet it will be accepted as a matter of definition that the term audio-visual methods and materials designate both types of experiences; direct and vicarious. In the Encyclopedia of Educational Research,[1] the term audio-visual is defined similarly. In other words, the term audio-visual methods and materials include all the methods and materials used in the classroom to facilitate the understanding of the written or spoken words.

B. What Are the Proven Contributions of Audio-Visual Methods and Materials:

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1. Encyclopedia of Educational Research, rev. ed., New York: Macmillan Co., 1952, p.84.

The following claims are distilled from a vast amount of significant research studies as described in the Encyclopedia of Educational Research.[1] As a result of these research studies, it has been found that audio-visual methods and materials, when properly used in the teaching situation can accomplish the following:

1. They supply a concrete basis for conceptual thinking and hence reduce meaningless word-responses of students.

2. They have a high degree of interest for students.

3. They make learning more permanent.

4. They offer a reality of experience which stimulates self-activity on the part of pupils.

5. They develop a continuity of thought. This is especially true of motion pictures.

6. They contribute to growth of meaning and hence to vocabulary development.

7. They provide experiences not easily obtained through other materials and contribute to the efficiency, depth, and variety of learning.

One of the most significant contributions of audio-visual methods and materials is that they actually enrich the learning experiences of students by providing varied and wide experiences which cannot be provided when the teacher relies completely on the "read-write, listen-speak" approach

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1. *Ibid.* p.84

to teaching. In order to see how the use of audio-visual methods and materials enrich the learning experiences of the students, let us compare the mere reliance on the "assign-read-recite" method of teaching chemistry with a field trip for example:

1. What is seen in the field trip is life itself with all its concreteness, thus learning is direct, life-like and interesting.

2. It has an influence on students' attitudes.

3. It arouses new interests in community problems, resources etc.; thus, it helps to socialize the student.

4. Incidental learnings may be higher in value than the original learning which the teacher enlisted in his planning of the trip.

5. Planning of the trip can be a cooperative effort. "What to look for", "Standards of behavior" etc., can be determined mutually.

6. At the intended place, formality is out of place, work in small groups is encouraged.

Another example of how these methods and materials help to vitalize the school experiences of the students is the laboratory method. Informality, interest, thinking, group work, and cooperation are the common characteristics when this method is used properly.

Similarly an exhibit will capture attention, arouse interest, convey its message effectively and affect behavior and attitudes. Students can participate in planning the exhibit, in collecting materials for it and in evaluating it.

Another one of the contributions of these materials is that they increase the teacher's productivity and efficiency by releasing him from repetetive and elaborate technical work. Giving information, explaining, is a part of teaching. Over and over again, teachers are inefficiently using their energy to say the same things without illustrative pictures, films or opportunities for direct experiences to make what they say meaningful to learners.

Electronic means of communication will do the same explanations meaningfully as many times as required. A filmstrip, for example, will illustrate ideas in a way which is very difficult for any teacher to match. No teacher can afford to produce by himself all the illustrations found in a filmstrip to explain a single topic. It is too time consuming a job. Similarly an educational film can present demonstrations, explain ideas or bring together various concepts and facts in a meaningful context. Thus, it releases the teacher and provides him with an ample time and energy to do the task that modern education recommends of a teacher, namely, to improvise and design desirable learning experiences for students to the end that their behavior be developed into desirable directions. The teacher also will have time to study the learners; their differences, problems, needs, and experiential backgrounds. This will enable the teacher to give them a more sound and effective education.

Much of teachers' efforts are wasted by students' inattentiveness, lack of interest, or lack of sufficient experiential background. Experience and demonstrated good teaching practice have already proved that motion pictures, filmstrips, and television are all extremely effective means for awakening interest. Besides, they supply students with meaningful learning that helps overcome differences in experiential backgrounds among students.

Thus the quality and quantity of the teachers' work can be improved and increased when he uses audio-visual tools.

C. How to Utilize Audio-Visual Methods and Materials:

Proper utilization of these methods and materials is one of the greatest factors in the effectiveness of the learning that results. No one type of method or material must be used to the exclusion of others. Certain materials seem more appropriate for certain phases of learning. The kind of learning the teacher wants his students to have will determine the type of materials to use. When problem-solving is to be taught, the laboratory method is the best. On situations where a study of a process or objects in their natural setting is necessary, a field-trip will be highly desirable. The motion picture will be selected to bring into the classroom remote places, otherwise unobservable action, demonstrations, and dramatic presentations. A detailed study of visual content can be provided for by the use of slides, filmstrips, still pictures or other similar materials.

Perhaps, the total learning situation requires the use of more than one of the audio-visual materials or methods- a field-trip can be best followed up by a film, a bulletin board presentation or an exhibit related to the subject of the field-trip.

The following steps of utilization are usually applicable to all the audio-visual methods and materials:

1. Teacher preparation:

The teacher has to determine the purposes, select and preview the materials or improvise the experiences, prepare the room (as in the case of a demonstration, films, slides, etc.)

2. Class preparation:

The teacher has to arouse his students' interest, supply the necessary background, clarify difficulties, etc.

3. Show the material:

At certain instances, materials are to be shown, as in the case of films or other projected materials. At other instances, the teacher has to expose his students to direct experiences as in the case of a field-trip, a demonstration or a laboratory work.

4. Follow-up:

The teacher can follow-up an experience by holding a discussion on it, by testing his students either orally or in writing, by having more experiences or materials, and finally by evaluating the experience or the material itself as follows:

a. Did it lead to the original objectives i.e., did it develop understanding, interest and appreciation?

b. Did it train the mental processes of the student?

c. Was the material accurate, authentic, up-to-date?

d. Was the material or experience worth the time, effort, and expense?

CHAPTER IX

MODERN METHODS OF CHEMISTRY TEACHING

A. The Laboratory Method[1]

The laboratory method is a very effective method for teaching chemistry. Facts, laws, applications, are all made clear and meaningful by direct contact with them in the laboratory. The work in the laboratory satisfies some of the basic motives in human beings such as the urge for activity, manipulation and achievement.

However, the major purpose of giving laboratory work is to give some practice in the scientific method and its different aspects, such as the following:[2]

1. Raising and defining worthwhile problems.
2. Collecting evidence which may help in the solution of the problem.
3. Training in the use of control in experimentation, one variable at a time.
4. Exploration of students accompanied by teacher guidance.

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1. Some of the ideas in this section are derived from:
   a. Heiss, E.D., et.al. Modern Sciences Teaching. New York: Macmillan Co., 1951, pp. 117-118.
   b. Kieffer, W.F., "The place of the Scientific Method in the First Course in Chemistry," Journal fof Chemical Education, Vol. 31, June 1954, pp. 300-303.
   c. Mallinson, G.G., and Buck, J.V., "The Inductive Method in the Chemistry Laboratory," Journal of Chemical Education, Vol. 31, April 1954, pp. 634-636.
   d. Richardson, J.S., and Cahoon, G.P., Methods and Materials for Teaching General and Physical Science. New York: McGraw-Hill Book Co., Inc., 1951, pp. 29-36.
   e. Twiss, G.R., Principles of Science Teaching. New York: Macmillan Co., 1937, p. 24.
2. National Society for the Study of Education, 46th Yearbook, Part I, Science Education in American Schools. Chicago: University of Chicago Press, 1947, pp. 35-36.

However, laboratory work alone does not produce students who are scientifically-minded. To produce such results special attention should be paid totheirdevelopment.

Scientific method involves the forming of hypotheses and testing them by experiment. Hardly any of the formal regular work of laboratory is scientific for it demands of the students mere imitation rather than critical thinking. Experiments given either by teachers or followed in a laboratory manual amount to little more than "cook book" manipulations. The following is a typical laboratory manual arrangement:

Problem: To prepare and study the properties of oxygen.

Procedure: Set-up the apparatus as shown in the diagram. Mix .....g $KClO_3$ and .....g MnO_2 .....etc. Thrust a glowing splint into the bottle ..... etc.

Conclusion: The properties of Oxygen are ....,
(namely a blank to be filled in)

First, this is not a problem in any sense of the word. Problem exists only when the student finds himself in a perplexing situation in which he must seek answers in order to find a solution.

Second, the procedure is not the problem-solving procedure. It captures no interest either.

Third, the conclusion is not a solution of a problem and is not a generalization which governs many phenomena. The conclusion is only a statement of facts arrived at by observation.

Further, laboratory work is usually given after exhaustive reading and classroom discussion. Therefore, the students know the answer beforehand. They usually squeeze their conclusions into line with the formulations of the textbook.

To train the students in problem-solving they must be made to work on problems for which they do not know the answer beforehand and to reach conclusions themselves. In this case laboratory work should precede classroom discussion. However, this does not mean that the students are given no orientation before they work in the laboratory. On the contrary, they should be given enough background so that they will not be lost when they start their work. While the student is working on a problem the teacher should always be available for help and guidance.

Problems to be investigated by students do not have to be complex ones. They can be as simple as the following:

"What is the reaction between warm dilute nitric acid and the simple oxides of the common metals?"

The student investigates and finds that common oxides such as those of lead, copper, nickel, and cobalt dissolve readily in the acid. He can then formulate a general statement which he was not told of beforehand. To him it is a kind of a discovery which is usually accompanied by excitement and interest. The statement is: "The simple oxides of the following metals....., are all soluble in dilute warm nitric acid."

Another problem would be: "What is the effect of heat on carbonates of common metals?" The student then needs to know how to find out whether any thing has happened to the carbonate. Here, either the teacher or the student may suggest that an acid be added to a sample of the carbonate before and after heating. The student then heats the carbonates and discovers that the alkali carbonates will not decompose. He may conclude: "With the exception of alkali carbonates, all carbonates are decomposed into the oxide of the metal and carbon dioxide." Such simple laboratory experimentation work trains students in the inductive approach which calls for student initiative and thinking. It also arouses interest for it contains an element of discovery.

The above mentioned examples represent the inductive approach (which is the basic method of thinking in science) in its simplest form since no hypothesis was advocated. The following examples will show a more advanced application of the use of the problem-solving approach in the laboratory work in which the student has to formulate and test hypotheses.

The teacher may ask this question: "Why is iron often painted or nickel-plated as in the case of window bars or your pocket knives?"

This is a real problem.

Students may say that the reason is to prevent it from rusting. Then the teacher can add: "But why does iron rust?"

A student may suggest that it rusts because it unites with the air. (This is a hypothesis to the student who does not know about oxygen). You may add another hypothesis as follows: "Perhaps iron rusts because it unites with moisture-with water in the air."

Now students should be made to test these hypotheses by experiments in the laboratory. For example, they may test the hypothesis that water is the cause of rust by putting unrusted iron in a closed bottle full with boiled distilled water. The iron does not rust and the hypothesis is discarded.

Students may test the two hypotheses that iron either gives something to the air or unites with something in the air by weighing iron filings before and after they rust. The increase in weight indicates that iron unites with something in the air. To confirm the corrections of this hypothesis another experiment can be devised by students or suggested by the teacher as follows:

Steel wool can be stuck to the closed end of a test tube. This test tube is then inverted and lowered into a beaker of water until the mouth of the test tube is half an inch below the surface of water.

The steel wool will rust and water will rise to fill about one-fifth of the test tube.

After arriving at the conclusion that iron unites with a part of the air when it rusts, the students can then proceed to find out what is the nature of this part of air that unites with iron.

At this point, the teacher may suggest that students close the mouth of the above mentioned test tube underwater, take it out, fix it upright and introduce a glowing splinter into it. The fact that the splinter is put out, will lead the students to the conclusion that the part of air which causes iron to rust is the part that supports combustion.

By now, students will have had enough motivation which will facilitate further experiences and studies such as preparation and study of oxygen, how to put out fires, and similar topics.

The problem "why iron rusts?", and its solution according to the suggested method is a clear example of using simple problems to train students in the elements of the scientific method of problem solving.

Such problems can be devised by the teacher or by a committee of chemistry teachers with the help of science education specialists. Another example of problems, the solution of which involves the formulation of hypotheses and experimentation in the laboratory is the following:

<u>The problem:</u> How to remove an ink stain from a cloth.

<u>Collecting facts:</u> What is the composition of the ink stain, of the cloth, etc.

Formulating hypotheses:

a. We need an oxidizing agent (Mild, medium or strong).

b. We need a reducing agent (Mild, medium or strong).

Testing hypotheses: Different mild, medium and strong oxidizing and reducing agents are tried on the ink-stained cloth.

Drawing conclusions: The conclusion is: "To remove an ink-stain from a cloth, we need a mild reducing agent like ammonium oxalate."

Problems investigated by the students may also involve collecting information from books, journals, encyclopedias, and the like, besides experimentation in the laboratory. The following is an example of such problems:

"How can you tell whether coffee has been adulterated?"

To solve this problem, the student needs to know the composition of coffee, what compounds are produced when coffee is adulterated, and how to test for these compounds in the laboratory. Such information may be collected from the above mentioned types of references.

A similar problem is the following:

"How can you find out whether honey is natural or artificial?"

To solve this problem, the student has to know the difference between mono- and di- saccarides and how to test for the mono-saccarides. These facts can be collected from books. The student can then apply these facts to samples of honey to be sure that the solution which he has arrived at brings about satisfactory results.

To work on such simple problems, the solution of which is within the range of capacity of the students will arouse students enthusiasm and interest and will actually train them in the scientific method of investigation. Suspended judgement, open-mindedness , objectivity, and other elements of the scientific attitudes will be learned incidentally as the student is working on problems under the teacher's guidance.

Perhaps some would attack this method on the basis that it consumes time. But if we only recognize that ability to solve problems and de reflective thinking is invaluable, then less laboratory work that trains in thinking and problem-solving is much better than many experiments which train is nothing. However if the laboratory work is to be successful the teacher should regard the following points:

1. Enough background should be supplied to the students when they are given a problem on which they are to work . This does not mean that the student is given a detailed procedure or theory. Nor does it mean that the student should be left to sink or swim. Either extreme is not satisfactory.

2. While the student is experimenting the teacher should be constantly available for help. He should stand in a place where he can observe the progress of each and every student in the laboratory. The teacher should be in the

laboratory at all times.

3. Cautions and thorough instructions regarding hazards and possibilities of personal injury are very necessary. How to handle glass tubings, concentrated acids, hot materials, etc., should be made clear to every one of the students.

4. Students should be given a certain set of standard equipment for which they should be held accountable. During the first few days of the year, students should be shown the various pieces of apparatus and given simple explanations and experiments that are designed specifically to illustrate their characteristics. Obviously this is necessary if students are later to plan experiments that will provide evidence toward the solution of some problem in chemistry.

5. Students can either work individually(this is especially necessary when a student is working on a problem or a project of his own choosing) or in small groups where all the members cooperate in working out the solution of a problem. This latter method is excellent for it trains in cooperation, in open-mindedness, and consideration of critique and suggestions from various members of the group. Further, when a group works on a problem, individual's enthusiasm and activity receives a social reinforcement.

6. It is necessary that students keep a record of what they do in the laboratory. There are at least four major

parts in a written report of this kind. They are:

1. Statement of the problem undertaken.
2. The procedures used.
3. The observations made.
4. The conclusions drawn.

Drawing of equipment used may be included.

B. The Demonstration Method.

The demonstration method is an effective method for teaching chemistry. Students have natural curiosity and interest in actual objects and in seeing unfamiliar things. In the classroom a sample of an iron ore is an immediate center of interest. The demonstration thus is an excellent method of making chemistry interesting for students. For all students, seeing the actual thing is much more helpful than reading about it.

The demonstration is one effective method of providing experiences in thinking. The application of principles, the identification of assumptions, the use of controls, the testing of hypotheses, the drawing of conclusions, and the making of accurate observations, are phases of thinking which can be experienced in demonstrations. However, in order to develop thinking, demonstrations should be used in problematic situations; problems that demand the finding of certain facts and the discovery of cause and effect. This should be the main purpose of their use, though they may be used to illustrate and verify facts.

Demonstrations can be performed by the teacher, by one of the students, or by a group of two or three students. In the latter two cases the student or students should prepare the demonstration and "rehearse" it under the guidance of the teacher before they show it to the class. Even during teacher demonstrations, student assistants can be assigned to help in many ways. Students' participation creates interest on their part besides the valuable experience that they may have.

1. Different uses of demonstrations:

a. Demonstrations may be used to raise and define problems. For example, mix 500 ml. of water with 500 ml. of alcohol. The mixture will measure less than 1000 ml. Why?! Are there spaces between molecules?

b. Demonstrations may be used in developing skill in the interpretation of data and phenomena. An example is:

Spray charcoal powder on the surface of water. Touch the water at one end with a bar of soap. The charcoal powder will be moved away from the point of contact with soap. Why?! What is the possible explanation or explanations.

c. Demonstrations may be used to test students' hypothesis:

Does oxygen support combustion or is it combustible itself; what would happen if the nitrogen of the atmosphere were replaced by oxygen, etc.?

d. Demonstrations may be used to illustrate the application of principles. An example: is:

Mix equal quantities of sugar and potassium chlorate. Touch the mixture with a hot rod. The mixture burns brilliantly-why? What principle is being applied in this reaction?

e. Demonstrations may be used to develop in the students some skills as skill in using the sensitive balance, pouring reagents, operating certain equipment, cautions, and points to watch for. Evidences of good techniques, can often be stressed to a group of students by using the demonstration method.

f. Demonstrations can be used to test students' abilities and understandings. Such testing can be used in addition to the pencil-and-paper type. This was mentioned earlier in the thesis on p. 42 .

2. Criteria and Principles for Good Demonstrations:

Good teaching necdemands ability to explain well. The demonstration method is a good way of explaining and communicating ideas to the students. But to be a skillful demonstrator, the teacher needs to regard the following points:

a. Put yourself in the role of the observer:

This is much more easily said than done, for such role-playing requires thoughtful effort. The demonstrator knows his subject thoroughly, whereas the observers have little experience with it or none at all.

b. Watch for key points:

The "key points" are points at which an error is likely to be made, the places at which many students stumble. The good teacher recognizes these potential stumbling-blocks, prepares for them in advance, and puts special emphasis on them by repeating them or high lighting them in some way. For example, when the teacher has to perform a demonstration in which he has to dilute sulfuric acid, he should tell students "always add the sulfuric acid to the water, never the water to the acid". Sometimes it is possible to register a key point by dramatizing it in a manner that will make it remembered. "After collecting hydrogen in a number of bottles, keep one with its mouth up, then test for hydrogen in it. Your students will "see" that hydrogen has escaped. Thus they can arrive at the fact that hydrogen is lighter than air and therefore, will remember the key point that "bottles filled with hydrogen should be kept mouth down."

<u>c. Plan every step (including material) carefully:</u>

Make sure that every piece of equipment necessary is exactly where you want it to be. Nothing devitalizes a demonstration more quickly than a sudden interruption by the demonstrator, accompanied by, "Excuse me. I'll have to go to the laboratory to get the beaker-I must have forgotten it."

A check-list of necessary equipment is a simple means of preventing such a situation.

<u>d. Rehearse your demonstration:</u>

You ought to test the demonstration before showing it to students for clarify and workability. This will save you the embarrassing situation when your demonstration does not work in the presence of students. However, if the experiment "went wrong" despite your previous preparation, then do not get embarrassed, for even such experiments are valuable occasions for thinking. Involve your students in thinking to find out why the demonstration did not work, and valuable learning may result.

<u>e. Be sure that every one can see and hear</u>:

<u>f. Keep your demonstration simple</u>.

<u>g. Do not digress from the main idea</u>.

<u>h. Check continually that your demonstration is being understood:</u>

Watch your audience and learn to detect signs of bewilderment, bordom, or disagreement. If any of these is present, stop and clear up the difficulty. Do not get too absorbed in what you are doing to remember that your basic purpose is communication. Put questions to the audience as you demonstrate, to make sure that you are getting your ideas across. Encourage your students to ask questions whenever something is not completely clear to them.

<u>i. Do not hurry your demonstration:</u>

<u>j. Do not drag out the demonstration:</u>

<u>k. Keep summarizing as you go along:</u>

As you near the end of your demonstration, restate the key points so that the major ideas emerge:

"So far we have seen that.........",

"Thus far we have done............",

are useful cumulative statements which bring together what has been accomplished.

1. Evaluate your students' understanding after you have finished the demonstration.

C. Individual and Group Projects.[1]

For the present purpose, the term project may be considered simply as a problem upon which a student or a small group works. This problem may be of laboratory type, in which case the project is essentially the same as a laboratory experiment. The project may be a problem which would not involve the use of apparatus and chemicals. The making of a chart, the preparation of materials for a bullètin board or the preparation of a series of handmade slides are examples of this kind of projects. A student project may be concerned with such problems as the biography of a noted chemist, the historical development of a chemical device or process, or the discussion of the practical applications of an important principle. Project work may be given or reported upon in class or outside of class, as to the chemical society of the school, or to school assembly. The performing of a demonstration or an experiment may also constitute a student project. The obvious difference between an individual project and a group project is simply that the latter is carried out by a group instead of by an individual. Sometimes this

1. This section is summarized from Richardson, J.S. and Cahoon, G.P., op.cit., pp.37-54.

means that different students carry out certain parts of a project which can be put into a whole at the completion; in other instances all the group work together on the whole project. Examples of the projects that may be done by individuals or groups would be the construction of a model sulfuric acid plant, an atomic reactor, a cloud chamber, an electrolytic cell, a model of a uranium atom, a diagram showing the internal structure of a petroleum refinery, experiments in putting color in plastics, electroplating plastics, a model showing Frash process of mining sulfur, the chemistry behind a telephone and the like.

Richardson and Cahoon[1] summarize the advantages of projects by saying that:

> Projects..... have the advantage of providing for student work on problems relating to individual needs and interests. They give students an opportunity to experiment with the operation of devices, to explore ideas, to test their hypotheses, to delve into principles or applications that cannot be taken up in class. They furnish an opportunity to discover and nurture special talents and to overcome certain weaknesses. They provide a way to help develop needed self-confidence and the approval of the group......
> ....
> If the projects are related to problems of genuine concern to the student, the occasion for thinking are frequent and likely to be effective.

<u>Sources of projects:</u>

Students projects are often suggested in the following magazines:

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1. Richardson, J.S., and Cahoon, J.P., op.cit., p 37.

1. Journal of chemical Education.

2. The Sciense Teacher.

3. School Science and Mathematics.

4. Science Education.

5. Scientific American, etc.

D. Field Trips:

The use of field trips in teaching chemistry is a device which aids markedly in creating interest in chemistry. For a student, to leave the atmosphere of the classroom and to go down to a factory where materials are being produced and to follow manufacturing process from raw materials to finished products is an experience long-remembered.

A field trip may do the following:

1. It shows natural phenomena in their proper setting, and blends school with the outside world, putting students in direct touch, under learning situations, with things, relationships, environment, occupations, and functioning.

2. It stimulates interest in natural and man-made things and situations and enables the students to know intimately their environment.

3. It develops initiative and self-activity, making students active agents rather than passive recepients.

4. It effects a genuine socialization of school procedure. It helps bridge the school and society and makes school more related to what goes on in actual life. Thus it affects students' attitudes and ideas greatly and

encourages them to participate in community activities.

5. It develops keenness of observation and constructive and creative thinking.

6. It may arouse a student's interest in certain vocations as a career. He can get guidance and be grounded realistically in the requirements of such a vocation by the people visited in the field trip destination.

<u>The only limitations of field trips are:</u>

1. Poor guides who know nothing or little of chemical procedures. However, a preview of the destination by the teacher may help overcome this difficulty.

2. Most chemical changes take place inside large tanks and very little of the real process can be seen. Here is where follow-up is very necessary. A film which shows cross-sections, diagrams, charts, textual materials, all help effect a fuller understanding.

3. Students tend to be caught by extraneous distractions. If students are clear on what to look for, this disadvantage tends to decrease. Further, students should recognize the trip as a learning activity; not merely as an entertainment. While it should be an enjoyable experience, it also should be a serious undertaking.

<u>The most important factor for the success of the field trip is planning. This involves:</u>

1. A preliminary survey of the place.

2. Planning the activities. Students may be involved

in planning for this provokes their interest.

3. Determine the specific points to be looked for.

4. Discuss the problems to be aided by the trips, arouse the students'interest and prepare them for the trip.

5. Arrange for transportation. Inform your host beforehand. Inform the administration to arrange for finance, get parents approval, etc.

6. Plan for safety, meals, dress, lodging, apparatus, reagents to be taken, and other such things.

7. Make your agenda and keep to it.

8. Carry out the trip.

9. Follow-up and evaluate in terms of the purposes.

10. Leave a record for other teachers to benefit from.

Some possible field trips in Iraq:

1. Match factory.

2. Glass factory.

3. Textile factories.

4. Ice factories.

5. Soap factory, also elementary soap making in villages.

6. Petroleum fields and refineries.

7. Sulfur springs in Mosul's district.

8. Calcium carbonate and sulfate quarries.

9. Tanneries, modern and primitive.

10. Water purification plants.

11. Caves showing stalactites and stalagmites.

12. Trips for collecting samples of rocks.

13. Trips for collecting samples of soils.

14. Cement factories.

15. Bricks factories.

16. Lime-kilns and gypsum factories.

17. The hospital for seeing the x-ray technical laboratories, blood tests, urinalysis and the effect of medicines on the microorganisms.

18. A soft drink factory.

E. Co-Curricular Activities - The Chemistry Club

One way to arouse a high degree of interest in chemistry and to provide also for individual differences is the chemistry club. Students who show interest in more academic work, social work, or other activities may be organized into a club.

Values of the Chemistry Club.

1. It constitutes a wholesome way of educating adolescents for recreation.

2. It helps in developing worthy interests, knowledge and skills.

3. It has a healthy psychological impact on the adolescent for it helps him to be adjusted socially and gives him a sense of his worth and belonging to the group.

4. It helps establish closer community contacts, and by so doing it bridges the gap that at present exists between school and community.

5. It affords students with opportunities for planning activities, setting regulations, abiding by the group laws, and undertaking real responsibility.

6. The fields of activities can be extended into real life problems in the physical and social environment, thus making education more real and life-like.

What Is the Situation in Iraq ?

1. In the secondary schools of Iraq, there are no chemistry clubs as such. Instead, there are science clubs which sometimes incorporate mathematics as well.

2. This student-organization (as well as others) is sponsored by overworked teachers who either lack interest and faith in the values of such extra class group activities or lack proper training in such work.

What Should Iraq Do ?

A chemistry club is desirable in every secondary school. Besides the advantages listed before, this club would extend and enrich the chemical experiences of students, and would arouse interest in chemistry among members of the club. Students may visit places, tackle subjects, or perform experiments that are beyond what the regular course would offer.

Members of the club may perform some services for the other students in the school. They may prepare cheap kinds of ink, tooth powder, hair cream or hand lotion.

The sponsor of the chemistry club has a golden opportunity to educate his students in the scientific method of solving problems, in the scientific attitudes, or he may give them a real orientation in a vocation related to chemistry when they show interest in it.

Activities for chemistry clubs in the secondary schools are suggested in the Journal of Chemical Education at many places in every volume. It is, however, important to note that the sponsor of the Chemistry Club will not be able to offer his students his best if he is overworked. Therefore, he must have a reduction in his work hours so that he can carry out his club responsibilities well.

The Chemistry Library

Many books on different chemistry subject must be available for students to refer to if they want to do any research work or to follow an interest or to meet a need. Popular or semi-popular science magazines are also of vital significance.

The Arabic library is very poor in this respect. There is an enormous need for chemistry books written in Arabic, not only for academic purposes but for popular and adolescent student purposes as well. Such interesting books as "Science Experiences with Ten-cent store Equipment" and "Science Experiences with Home Equipment" by Lynde[1], and "Mystery experiments and Problems" by Frank and Barlow[2] and "Simple Chemical Experiments" by Morgan[3] and the like are very valuable to any chemistry class or club.

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1. New York: D. Van Nostrand Co., Inc., 1950.
2. Oshkosh, Wisconsin, Published by J.O.Frank, 1949.
3. New York: Appleton - Century - Croft, Inc., 1941.

Popular Science, Scientific Monthly, Journal of Chemical Education, and other similar journals are certainly useful to both teachers and students. A variety of secondary school chemistry textbooks, a formulary and similar reference books are also necessary. If these journals and books cannot be provided to every secondary school, then, they should at least be provided to the public library in every city where students and teachers can use them.

CHAPTER X

MODERN MATERIALS OF CHEMISTRY TEACHING

A. Microprojector.[1]

The main advantages of the microprojector in teaching chemistry are the following:

1. It is relatively inexpensive because a single group-used projector replaces a number of individually used microscopes.

2. It presents a greatly enlarged picture of the specimen, object, or action.

3. It is easily operated by the teacher, and saves the time wasted in adjusting the vision when individual microscopes are used.

The following are a few of the phenomena which can be presented by the microprojector:

1. Surface tension phenomena with films on acqueous and other solutions. With the use of special slides made with a well in the center, soap solution and oil films of varying viscosity are strikingly projected under low-power magnification as well as high power. Dropping dispersing agents on the surface while in projection also shows the break down of the surface films.

2. Brownian movement with high-power oil-immersion projection.

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1. This topic is summarized from: McKown H.G., and Roberts A.B., Audio-Visual Aids to Instruction. New York: McGraw-Hill Book Co., Inc., 1949, pp.512-513.

3. Physical examination of wool, cotton, silk, rayon, linen, or other textile fibers. By lightly staining in carmine, easine, or other dyes and use of balsam with cover glasses, permanent slides for projection may be made which will give excellent results in identification of fibers. Effect of various solutions on fabrics may also be shown as well as laundering effect with soap and detergents.

4. Migration of charged particles in solutions. By constructing a special slide with a rectangular well and platinum electrodes connected to a polarized circuit, the migration of charged particles in electrolytes can be dramatically shown. The electric character of charged particles is made clear to the student by this technique. A reversing switch can be used to show changes of migration while being projected, and the results are dramatic in effect. Colloidal solutions are particularly well adapted to this work. The students easily grasp the significance of ionic charge and migration.

5. Examination of the properties of crystals and other small forms of matter.

6. The projection of crystal growth in solutions. Some suitable and interesting growth patterns are shown in the crystallization of ammonium chloride, sulfur in carbon bisulfide, sodium nitrate, copper sulfate, sodium chloride, potassium dichromate, sodium hyposulfite and potassium

chlorate. It is important to show melting under the effects of the heat of the arc beam by moving the cooling cell out of the light path and to show subsequent crystallization without changing the field of projection.

7. The Tyndall phenomena in colloidal solutions.

8. All materials now available on microscope-prepared slides can be projected in the microprojector.

It should be cautioned, however, that the beam is cooled to the degree necessary to prevent damage to the material mounted on the slide.

B. Motion Pictures.

Motion pictures are considered among the most effective teaching tools. They can portray scenes, processes, events, and actions, more nearly as they appear in real life than other materials. In the Forty Sixth Yearbook of the National Society for the Study of Education,[1] the use of the motion picture in science teaching is highly recommended. There, it is maintained that when direct experience is impossible, a good substitute may be the motion picture.

Perhaps in line with the old Chinese saying "A picture is worth 10,000 words", one may say that a motion picture is worth 10,000 pictures or even more.

Motion pictures can illustrate phenomena which

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1. National Society for the Study of Education, Forty Sixth Yearbook Part 1, Science Education in American Schools. Chicago: University of Chicago Press, 1947. p.101.

cannot be seen by the naked eye such as the structure of atom, how chemicals react, or how atomic fission takes place. The inherent characteristics of the motion picture including animation, micrography, time lapse photography, slow motion, and speeded-up motion make possible a realistic understanding of abstract subjects and events of chemical interest.

Frank[1] believes that the chief value of the motion picture in chemistry teaching lies in its power to show the dynamic items where motion and continuity of action are involved. Examples are: motion of ions and molecules, transfer of electrons, various kinds of reactions such as combination, decomposition, substitution, and similar types of items. Since the dynamic items in chemistry are among the most abstract and difficult to teach, the motion picture offers a prominent help in the field of chemistry.

All topics in chemistry which lend themselves to teaching by demonstration also lend themselves particularly to motion picture projection. Films can also show the work inside plants and factories which utilize the science of chemistry in their work.[2] Films can be on topics as the following: Alcohol, abrasives, cement, explosives, copper, silver, gold, aluminum and other metals mining and smelting,

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1. Frank, J.O., Teaching of High School Chemistry. Wis: J.O. Frank and Sons, 1932, pp.174-177.
2. See for example the Journal of Chemical Education, Vol.7, (Dec. 1930) pp.2926-27 in which 332 films dealing with different subjects of chemistry are named. The films nearly touch on all the topics of general chemistry.

glass, iron, steel, rubber, soap, matches, textile, and sugar industries, the science of electrochemistry, atomic structure, atomic energy and its peacetime uses in agriculture, industry, medicine, and a host of similar topics. Such films are important in Iraq, because there are only a few chemical industries.

What Research[1] Has Proved About Films

1. They can show motion and processes especially those which are not visible to the naked eye.

2. They can get at the inaccessible.

3. They compel attention and arouse interest. This increased motivation may spread to other learnings. A number of studies have shown that viewing a film stimulates voluntary reading and group discussion or other learning activities.

4. Films increase factual knowledge.

5. The use of effective and appropriate films result in more learning in less time and better retention

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1. This section depends on the following references:
(a) Hoban Jr., C.F., and Van Omer, E.B., Instructional Film Research, Pennsylvania State College, 1951. This reference consists of a critical evaluation and summary of experimental literature on instructional films (1918-1950).
(b) Encyclopedia of Educational Research. New York: Macmillan Co., 1952, pp. 84.
Many research studies about various uses and advantages of films are evaluated and summarized in this reference.
(c) The School Administrator and His Audio-Visual Program. Washington: Department of Audio-Visual Instruction, National Education Association, 1954 Yearbook, pp. 273-274.
Many research studies about values of films in relation to different learning outcomes are reported in this yearbook.

of what is learned. More than a hundred studies have been made in which there has been a pretest of information, the showing of film, and then a retest. The above-mentioned generalization rests on the results of those studies.

6. Films in combination with other instructional materials are better than either alone.

7. Films facilitate thinking and problem solving. Carefully conducted research[1] studies demonstrate that people taught with films are better able to apply their learning than people who have had no film instruction.

8. Films affect attitudes and change motivations and opinions.

9. Films are equivalent to a good instructor in communating facts or demonstrating procedures.

The present situation in Iraq may present the following difficulties in the way of using films effectively:

1. Because students are not accustomed to the use of motion pictures in the classroom, they may consider them as entertainment.

This can be guarded against by proper student preparation. A list of things to look for in the film, or questions to be answered by the film, should be developed in the classroom before showing the film. Students also should understand that they will be responsible for the material in the film as a follow-up.

2. Teachers are not trained to use films in their teaching. They do not know how to operate the motion picture projector. This difficulty can be overcome by in-service

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1 . Hoban Jr., C.F., and Van Omer, E.B., op.cit., pp.

education as will be explained later.

3. Buildings are not prepared for showing films. Classrooms lack darkening and lighting facilities, proper ventilation, and accoustical treatment. One possible solution to this problem is to prepare the auditorium or a free classroom for the purpose of showing films. Although showing films in the classroom is a more effective procedure, yet, this solution is inevitable for the present time.

4. Expensiveness of equipment and films may hinder their use on a large scale. This problem may be solved by establishing an audio-visual center in each one of the 14 Liwa's (counties) of Iraq. Schools of the Liwa' may be scheduled for the use of films. Such a center may also provide projectionists to operate the equipment in schools where teachers are not trained in handling the motion picture projector.

Some Sources of Motion Pictures:

1. American Petroleum Institute, 50 W. 50th St. New York 17, N.Y.

2. Coronet Instructional Films, 65 E, South Water St., Chicago 1.

3. Council on Atomic Implications, Inc., Box 296, University of Southern California, Los Angeles 7.

4. Encyclopedia Britanica Films, Inc., 1150 Wilmette Ave., Wilmette I ll.

5. General Electric Company, Visual Education Division, 1 River Rd., Schenectady 5, N.Y.

6. McGraw-Hill Book Co., Inc., Text Film Dept., 330 W. 42nd St., New York 36, N.Y.

7. Scientific Film Co., 6804 Windsor Ave., Berwyn 1, I 11.

8. Shell Oil Co., Inc., Public Relations Dept., 2 Park Ave., New York 16, N.Y.

9. Society of the Plastic Industry, Inc., 295 Madison Ave., New York 17, N.Y.

10. Young America Films, Inc., 18 E 41st St., New York 17, N.Y.

G. Television

This is a new and effective tool which may be used effectively in teaching chemistry. Television has all the advantages of the motion picture with its realism and significant effect on attitude plus the added effect of immediacy, where spectators are captured by the fact that the scenes observed on the television screen are actually taking place at the same time.

Television originally was used in the United States for entertainment and commercial purposes. Only recently has it gained a real role in educational matters. Fortunately, Iraq has introduced television directly for the educational cause. Iraq is the first Arab country that has television. Its success in Iraq may inspire other Arab countries to introduce it for the same purpose.

Television can be an effective tool which may take the place of some direct experiences in chemistry teaching when these cannot be made available. It can bring the refineries of Baghdad, Basra, and Kirkuk, the soap and coca-cola factory in Baghdad and the tanning factory in Mosul into the classrooms of schools in all parts of Iraq. This will concretize many of the abstract and descriptive concepts and processes in chemistry. Such televised experiences could be better than real experience itself. The television lens can be made to take scenes inside the soap tank or very near to the smelted iron or small objects. In real field trips the students will not be allowed to go near these dangerous places, while some of the students at the back of the crowd would usually miss many important details. In the television program, all the students will be viewing from the same angle and the close-up method of photography would fill the whole television screen with even microscopic details.

A temporary solution to present ignorance of chemistry teachers in operating and using film projectors can be solved by televising such films to allstudents all over Iraq. Of course, such televised programs should be scheduled during the school day. Teachers should be briefed on such programs before hand. They should be offered instructional hints as how to prepare students for the coming program or how to integrate the program in the total learning situation.

D. Models

Models are very effective in teaching certain concepts and principles in chemistry. With the use of models, many concepts which are difficult to present with pictures, diagrams or discussion can be readily taught.

Slabaugh[1] for example, illustrates how models made of wooden balls and sticks can visualize the way in which chemists conceive molecules are formed from atoms. If these special balls and sticks are not available, a child's "tinker toys" set can substitute nicely and the teacher or the students can build molecule arrangements from the simple H_2O to the elaborate $C_{12}\ H_{17}\ N_4\ OSCl.\ HCl$, the formula for thiamine (vitamin B_1). By means of these models the concepts of combination reactions, decomposition reactions, and ionization can be made vivid. The teacher may also demonstrate atomic or fission as it is used in making an atomic bomb. The chain reaction is illustrated by the use of mouse traps. The first trap activates two traps, each of these activates two more, and so on it goes faster and faster. Little balls can be put on the traps to be shot representing the emitted neutrons. At the end of the chain reaction two balls which are colored differently can be put on each trap to represent the end product of the fission. Other examples of models in chemistry are the following: Models to illustrate the size of a liter and the size of 22.4 liters; models to illustrate the structure of atoms, a nuclear reactor, a petroleum refinery, a sulfuric acid plant, a cyclotron, and so forth.

As has been explained before under "student projects," the making of many of these models can be assigned as projects for individual students or for groups of students. Chemistry

1. Slabaugh, W.H., "A Lecture-demonstration of Nuclear Energy", Journal of Chemical Education. Vol. 25, 1948, p.679.

teachers may make some of these models. Help from the art teacher of the school and interested laymen of the community should not be overlooked. Some of these models (as the molecular models) are ready-made and can be ordered from the United States or elsewhere. Student-made models are sometimes more effective than commercially-made ones. The fact that students have worked to produce them will make the ideas and principles which these models represent clearer and long remembered. Further, such work would constitute a wholesome method of satisfying the need of students for achievement and for self-expression.

The following are some of the possible sources of models:

1. American Institute of Steel Construction, Inc., Dept. of Educational Services, 101 Park Ave., New York 17, N.Y.

2. American Petroleum Institute, 50 W 50th St., New York 20, N.Y.

3. American Potash Institute, 115 Sixteenth St., N.W., Washington 6, D.C.

4. Central Scientific Co., 1700 Irving Park Rd., Chicago 13.

5. New York Scientific Supply Co., Inc., 28 W 30th St., New York 1, N.Y.

6. Pittsburgh Plate Glass Co., Public Relations Dept., 632 Duguense Way, Pittsburgh 22.

7. Ward's Natural Science Establishment, Inc., Rochester 9, P. O. Box 24, Beachwood Station, New York.

also

E. Exhibits, Museums, and Science Fairs[1]

Exhibits consist of carefully prepared arrangements of objects, specimens, models, and sometimes still pictures to show interrelationships and to suggest processes in a static way. They also vitalize and add interest to the study of any topic. An exhibit helps students learn because of the following factors:

1. It concentrates attention and interest by using bright colors, moving figures, unusual shapes, flickering lights, and the like. It also helps concentration by highlighting only one idea and eleminating unnecessary details.

2. It explains abstract ideas by relating them to concrete objects.

3. It brings scattered facts together to form a new concept.

Exhibits can be highly professional as in the case of the exhibits presented at the UNESCO in Beirut on "Atom for Peace". Such exhibits are to be visited. Exhibits can also be teacher or student-made. Such exhibits are very valuable. They usually consist of collections of materials classified and housed in cases and put in a special exhibit rooms, inside the classroom or in the laboratory. Some

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1. Some of the examples and ideas in this topic are taken from: (a) Bell, A., "Chemistry Exhibits" Journal of Chemical Education. Vol. 5, March 1928, pp.280-90. (b) Condon, R., "Chemistry Exhibits in the Small Laboratory" Journal of Chemical Education. Vol. 7, July 1930, pp.1649-55.

examples are: the minerals of the locality or of the whole country, the manufactured materials of the locality or of the whole country, collections of samples of soils or specimens of rocks, and the like.

Exhibits in chemistry can be other than collections. They can be a number of materials, arranged carefully around a certain idea or topic such as "Kinds of Glass", Steps in Manufacturing Cement, Matches, or Pottery","How to Process Your Photograph", etc.

When enough of these collections and exhibits have been obtained at a school, they can be housed in a special room which may be labeled: " The Chemistry Museum". In building up such a museum in the school, students'interests are catered for by encouraging them to develop individual projects oftheir own choosing. Students may develop worth-while hobbies from out of class projects and activities. Students may work on projects to enrich the "Chemistry Museum". Such projects may include the building of atomic models, preparing of maps of chemical industries or products, preparing crystals,plastics,etc.

Materials and exhibits collected in the Chemistry museum may be presented at the end of the year in what is called the "science fair" where the work of the students is actually shown to the community, parents, and teachers of other schools(whos may adopt many ideas out of these science fair exhibits).

In the science fair, demonstrations should be performed by the students.

The following are the standards for making an exhibit:

1. An exhibit should convey its message clearly without the necessity of too much reading on the onlookers' part. An exhibit is seen,not read.

2. Put exhibits where they can be seen in the corridoors, in the auditorium, or in the classroom. They should not be put where the crowded onlookers may block traffic.

3. Put only one big idea in each exhibit.

4. Plan the exhibit in terms of your learners. You need to put yourself in your "audiences" shoes.

5. Make labels short, simple, uniform, legible, and readäble from a suitable distance.

6. Use sound, motion, color, and light to attract and hold attention.

7. Plan so that the observers push a botton, pull a device, handle, or operate materials. Their interest will be greater when they are involved in this way.

F. The Stereoscope.

This device is an individual optical instrument which gives the illusion of a third-dimension to certain still pictures called stereographs. It can enrich and add interest to the study of chemistry because it offers a most life-like realism to all photographs used with it.

A good example of the use of the stereoscopes in chemistry teaching is when a proper concept of the structure of the atom is needed. It is difficult to portray the structure of the atom in two dimensions, particularly on the chalkboard. The use of the stereoscope, because of its third dimensional effect, will, then,greatly assist in the understanding of the structure of the atom.

Mines, factories, refineries, and the like may also be shown in the stereoscope. If color is added to these stereographs, then they will rival reality itself.

G. Filmstrips and 2"x2" slides.

Filmstrips are related series of transparencies of still pictures on strips of 35 mm. film (acetate base).

They usually consist of20to100 individual pictures on one roll. Verbal explanations are provided by titles, an accompanying guide, a record, or by the lecturer.

2"x2" slides are individual pictures (often called transparencies) of 35 mm width (the same as any single picture in a single frame of a filmstrip) mounted with ready-made mounts or placed between two pieces of clear glasses for protection.

Both filmstrips and 2"x2" slides may be projected on the same combination projector and are effective teaching tools although they may not be as dynamic as a moving picture. The adtantages of 2"x2" slides and filmstrips (in common) are:

1. They focus the attention of the class on the subject at hand.

2. They can be taken by any 35 mm camera.[1]

3. They are suited to presenting visual materials such as pictures, charts, cartoons, graphs, diagrams, tables, etc. Therefore, they are versatile media suited to any subject and grade level. They can present complicated illustrations which are difficult for the teacher to produce by himself, thus they save his time and facilitate his job.

4. They can be projected on the screen for any length of time required. Visual content in them may be made the center of a group discussion.

5. They are easy to store and file.

6. They (and also their equipment) are relatively inexpensive.

Filmstrips are presently being produced to correlate with textbooks. McGraw-Hill, Raw-Peterson and other book companies are producing such correlated filmstrips and slides.

They are very desirable for showing technical and industrial processes. They can also explain material in a sequential order, such as the theories which lead to understanding the structure of the atom. The steps in the metalurgy of a metal. Virtually anything that can be photographed can be put on filmstrips or slides. Both slides and filmstrips

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1. The techniques of making filmstrips and 2"x2" slides are explained well in the following booklets:
(a) How to Make Filmstrips, produced by Eastman Kodak Co. Rochester 4, N.Y.
(b) Kodak Data Book on Slides (Free of Charge), produced by Eastman Kodak Co., Rochester 4, N.Y.

are valuable in showing the setting in which chemical processes are being carried out and in developing an understanding of the kind, size, and space relationship of various pieces of apparatus and parts of chemical industrial plants.

Many industrial and educational concerns produce slides and filmstrips which are of chemical interest. The following are some examples of them:

1. The Central Scientific Co., 1700 Irving Park Rd., Chicago 13.
2. Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago 40.
3. American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.
4. The United States Bureau of Mines, Pittsburgh, Pa.
5. The Westinghouse Electrical Co. E. Pittsburgh, Pa.
6. The General Electric Co. Schenectady, N.Y.

H. Handmade Slides.

They are usually of 3¼"x4" size. Their major advantages are:

1. They are easy to make either by teachers or students.

2. They can be made especially to satisfy a specific need of the teacher and the class.

3. They may be made to suit any grade-level or any topic.

These slides can be drawn on frosted glass, gelatin or lacquer-coated glass, or on tracing paper. They also may be photographic transparent positives.

Ideas for these slides can be copied from reference books, magazines, etc. Many subjects in chemistry can be presented on slides. Some examples are: the distribution of electrons round the nucleus, Rutherford's theory, the nature of certain chemical bonds as in sulfuric acid, and other similar topics.

Frosted glass may be obtained from Keystone Company[1], from local photographic stores or it may be made locally by using valve grinding compound on regular window glass.

Details of making handmade slides are very clearly explained in the following references.

1. Richardson, J.S., and Cahoon, G.P., Methods and Materials for teaching General and Physical Science. New York: McGraw-Hill Book Co., Inc., 1951, pp.97-101.

2. Hamilton, G.E., How to Make Handmade Lantern Slides, distributed free of charge by the Keystone View Co., Meadville, Penna.

3. Lantern Slides and How to Make Them, distributed free of charge by Bauch and Lomb Optical Co., 786 St. Paul St., Rochester 3, N.Y.

I. Still Pictures.

They are representative illustrations of the real things. They consist of drawings, illustrations, photographs, cartoons, comics, and magazine pictures. Still pictures are life-like and interesting and enable us to get at the inaccessible. They are abundantly available, most readily

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1. Meadville, Pa.

accessible, cheap, versatile, and can be easily filed and stored. Yet in using pictures:

1. Be careful not to distort notion of size.

2. Select pictures suited to your teaching purpose, which are accurate and of good technical quality.

3. Prepare students to look for specific points in the picture. Don't merely expose it, but explain it. Interpreting picture cues differs with the experience of the individuals and with cultures.

Still pictures can be used on a bulletin board, in an exhibit, in opaque projector, on feltboard, shown to the class as a whole, or for individual study at learner's rate, level, and interest. Many magazines and companies also present pictures pertinent to chemistry.

The following are some examples of sources of pictures:

1. Professional magazines.

2. Popular magazines — Life, 9 Rockefeller Plaza, N.Y. 20, National Geographic, 1146 Sixteenth St., N.W., Washington 6, D.C., Ahlu-nift (of Iraq Petroleum Companies).

3. Classroom Informative Pictures, Grand Rapids, Michigan.

4. Creative Education Society, Mankato, Minn.

5. Industrial Companies such as General Electric, Schenectady 5, N.Y., United States, Steel Corporation, 429 Fourth Ave., Pittsburgh 19, Shell Oil Co., 50W, 50th St., N.Y. 20, etc.

J. Graphic Materials

These can be posters, charts, diagrams and graphs. They are devices which communicate ideas clearly and forcibly through the combination of drawings, words, and pictures. Their chief instructional value lies in their capacity to attract attention and to readily convey information in a condensed form.

Posters are dynamic media which hold attention and convey their message in a compact form, put across an idea quickly or emphasize a subject effectively. Posters are always used as motivational device. They should always include one main idea. They may be usedto warn students to work under a hood in the laboratory, to warn them not to look into a heated test tube from above, to tell them to hold stopper between fingers and not to lay it on the table, or to show them how to boil liquids in a test tube.

Charts visualize relationships between key facts and ideas in an orderly and logical way. They may also show comparison, classification, development, and organization. They may illustrate various chemical processes, different industrial uses of a certain compound such as sodium chloride or sulfuric acid. The following are some examples of charts in chemistry:

The periodic chart of elements, the chart showing atomic weights and numbers, the chart showing the spectra of the common metals, the chart of the borax head metal tests in color, nuclear physics charts, and so forth.

Charts may be obtained from apparatus or chemical supply houses and from industrial concerns. Some industrial concerns offer charts free or for a low cost. The following are examples of some of the firms from whom charts may be obtained:

1. The Central Scientific Co., 1700 Irving Park, Blvd., Chicago III.
2. The Fisher Scientific Co., 709 Forbes St. Pittsburgh Pa.
3. Westinghouse School Service, Westinghouse Electric Corp., 306 Fourth Ave, Pittsburgh 30.
4. Shell Oil Co., Inc., Public Relations Dept., 50 W 50th St., New York 20, N.Y.

Many charts also can be found in books, magazines, and pamphlets. These can be enlarged by the teacher by one of the following methods: projection method, grid method, proportional dividers, or pantograph.

Students may help in such work.

Graphs are visual representations of numerical data. They are inherently more interesting than mere number tabulations. Graphs can be of a line, bar, pie, area, or pictorial type. They can be used whenever comparisons between numerical data are required as in showing the variation of solubility of different compounds in water or other solvents at different temperatures, or in showing the increase of oil production in Iraq from 1925-1955, or other similar topics.

Diagramsare single line drawings including only the chief elements of an apparatus, equipment or structure, represented in lines and symbols. Diagrams are used extensively in books of chemistry such as the diagram of the apparatus for preparation of hydrogen or the diagram of an electrolytic cell, etc.

Due to their rather abstract nature, diagrams, graphs, and charts need careful student-preparation. Sufficient background of first-hand experience is necessary if the students are to understand them properly.

K. The Bulletin Board.[1]

The bulletin board is a device for displaying to learners, graphic, photographic, or other materials. This may include drawings, themes, texts, and three-dimensional objects, or any combination of these which are pertinent to the general areas of classroom study and learning activity. The bulletin board enables the teacher to show thoughts in some visual way.

Its chief advantages are:

1. It is a versatile medium because it may be used for all subjects and grade levels.

2. It can be a motivational device. Information may be presented on it in a pleasant, interesting, and vitalized form.

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1. The following references were used in preparing this topic:
(a) East, M., Display for Learning, New York: Dryden Press, 1952, pp.328-255.
(b) Koskey, T.A., Baited Bulletin Boards, California: Globe Printing Co., 1954.
(c) How to Keep Your Bulletin Board Alive. (A filmstrip) Produced by the Teaching Aids Laboratory, The Ohio State University.

3. It educates students in cooperation (by participating in planning, gathering materials, and evaluation). It also educates students in creativity and responsibility. Students may be made responsible for planning, for writing captions, etc.

The best procedure in planning and setting up an effective bulletin board display is:

1. Decide upon, one idea around which to build your display. Always start with the idea, not the available materials. As you are thinking on the idea, considering the concepts and facts that go under that idea, always think in terms of the intended "audience," their needs, experiences and level of intelligence.

2. Work out a caption that is short and attractive.

3. Gather the required material.

4. Plan the arrangement.

5. Execute and evaluate.

The arrangement of the bulletin board is the most determinant factor in its effectiveness. The teacher must use balance, directional lines, center of interest, texture, color and different means of attracting attention such as using "you" to involve the on looker; posing a question, or using motion, light, sound, movement, and three-dimensional objects.

It is preferable to have the bulletin board inside the classroom. It can be made of linoleum, cork(best), composition board or plywood, either alone or covered with burlap, or monk's cloth. Wire mesh may be used as a bulletin board. Wires stretched tightly on the wall may also serve as a bulletin board. The bulletin board also may be made of a magnetized material in which case small magnets of different shapes and colors may be used instead of tacks to fix materials on the board.

Pictures, clippings, from the news, drawings, actual objects, can be arranged about a central idea which is of particular interest to the class. "The Chemistry News Letter" of the week, notices to chemistry classes or club, pictures of chemists and their discoveries and work and a host of similar items can be posted on the bulletin board. The following are some suggestions for bulletin board topics: sugar as a food, atomic structure of matter, peacetime uses of atomic energy, different uses of plastics, common salt in every-day life, and the like.

L. Clippings From the News[1]

Because chemistry has brought about so many changes in our lives, the press is full of news about recent discoveries, hypotheses that are being tested, and theories that are being attacked. We expect even greater things in the future. We expect a cure for cancer, new synthetic fibers

1. This topic has been adapted and summarized from:
(a) East, M., Display for Learning. New York: Dryden Press, 1952, pp.135-146.
(b) Science Reasoning and Understanding. Dubuque, Iowa: W.M.C. Brown Co., 1954.

for our clothes, atomic energy to power our automobiles, new findings about vitamins and other food factors, etc. Students of chemistry should maintain a news board for at least two reasons.

1. It gives them a realistic appreciation of the importance of the subject matter. If they see how chemistry works to increase their personal welfare, they will be more interested in "valence" and "molecule." If they see examples of chemistry principles operating in everyday events, they will be more excited about their own "experiments".

2. To find examples of scientific method, both technical and logical. One of the most important objectives of science and chemistry is to give students an acquaintance with and experience in the use of the logical methods of science. The news furnishes examples of the use (and misuse) of such methods as observation, experiment, inference, comparison and classification.

News of such controversial problems as the use of atomic power can stimulate the application of the inductive methods of reasoning.[1]

These clippings collected by the teacher and students, should be mounted, headlined and displayed carefully on a bulletin board. They must be kept up-to-date. Teachers should make use of good bulletin board arrangements such as directing lines, colors, and other ways of attracting attention.

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1. Look back into p.100 where "How to use the news articles to develop students' thinking" is explained.

H. The Flannel Board

The flannel board (or felt board) is an inexpensive easily made device which may be used effectively to visualize many concepts and facts. It is made of a board (plywood, cardboard or any such material) over which flannel or felt is stretched tightly, fixed on the back of the board with scotch tape or tacks, and framed. It may be of any suitable size. The color of the felt or flannel can be as desired, but it is preferable, however, to have a neutral color such as grey or beige.

Pictures, illustrations, diagrams, chemical symbols and signs (as + , →, =) can be cut out of paper and backed with sand paper, felt or flannel, or they can be cut directly from a piece of felt. The backed illustrations or the felt cut-outs will stick to the board once they are pressed to it, requiring no tacks.

One of its unique uses is that the teacher can use it to develop any lesson, that has to be explained in sequential steps. An example is teaching how to balance equations of ordinary reactions and of oxidation - reduction reactions. Signs and symbols of the reactants and the resultants may be placed on the board. As the various arguments which should go with balancing an equation are considered, new signs of numbers, multiplication, electrons, connecting lines, etc., may be placed step after step until the whole equation is completely balanced.

Another example of its use is the following:

The teacher may put the signs of the reactants on the board and require students to put the signs of resultants on the opposite side.

Substitution and addition reactions in organic chemistry may also be explained by placing the structural formula on the board and manipulating symbols to show how the reaction takes place.

In fact, the flannel board is a versatile medium which can be used just as a portable bulletin board plus the possibility of manipulation and of quick change and rearrangement. The manipulation, however, can be done by the teacher or by the students.

N. The Droodle Board (or Flip Chart)

The droodle board consists of a number of large sheets of newsprint, backed by a large wooden or pressed board, and held at the top by a couple of nails or by more elaborate device of two thin wooden boards pressing the papers together, all secured by two screws and wing nuts. This allows the papers to be "flipped" or completely removed one at a time or as desired. One side of the board can be covered with flannel and the other with cork. Thus it serves three purposes: a portable flannel board, a portable bulletin board, or a droodle board. The major use of the droodle board is to enable the teacher to prepare in advance complicated illustrations and diagrams, summaries of certain topics, major steps in proving a theory or in preparing a compound, etc.

Therefore, it saves the teaching time in the classroom. The same materials can be used again and again if they prove successful. The teacher can use either the felt pen or crayons to write or draw on the papers.

O. The Electric Board

The electric board is a board of plywood or of any other non-conductive material such as thick cardboard. On the top is placed a bulb, a bell, or a buzzer, and into the board are driven many screws in two raws. Pictures and their names, questions and their answers, reactants and their resultants, etc., may be placed opposite the two raws of screws. The question and its answer, for example, are placed other than opposite each other (to prevent giving away the answer). When the terminals of two extension wires are put, one on the contact point of the question (the screw), and the other on the contact point of the right answer, a circuit is closed making the bulb glow or the bell ring.

Directions for making the electric board may be found in many audio-visual books.[1]

The electric board provides a pleasant way of repetition of materials to be learned such as electrolytic reactions, types of reactions, kinds of chemical bonds, etc. Thus it aids in reviewing and emphasizing certain important facts or principles. Students can use the electric board to test their mastery of the subject without the necessity of the

1. See, for example: Lemler, F.L., and Leestmax R., Supplementary Course Materials in Audio-visual Education. Michigan: Slater's Book Store, Inc., 1953, p.82.

presence of the teacher. A question with multiple choice answers, may be placed on the board. The teacher may find many uses for the electric board in connection with a variety of topics.

In short, it is an interesting and effective self-testing device.

P. The Chalkboard

The chalkboard is a constantly available visual medium for drawings, illustrations, and writing. It is a versatile medium which can be adapted to all grade-levels and subjects. It also permits quick change and rearrangement.

Artistic ability is not a necessity in using the chalkboard effectively. The following techniques will help the chemistry teacher improve his utilization of the chalkboard:[1]

1. Template:

It is a piece of heavy cardboard, or plywood cut into the shape of a beaker, Erlenmeyer flask, the bunsen burner, etc. These and similar other symbols, designs and diagrams can be easily reproduced on the chalkboard by means of the templates. The teacher can hold the template against the chalkboard and trace its outline with chalk.

2. Projection Method:

If the teacher wants to enlarge a picture, he may project it on the chalkboard by means of an opaque projector

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1. Detailed points of utilization of the chalkboard can be found in: (a) Wittich, W.A., and Schuller, F.S., Audio-visual Materials - Their Nature and Use. New York Harper and Bros., Publishers, 1953, pp.37-58. (b) Chalkboard Utilization, 1953 (A motion picture) Produced by Young America Films.

or a 2"x2" projector, then he may trace it. If projectors are not available the teacher may then use the squares method or the pantograph.

3. The Squares Method:

It may also be called the grid method. The picture which is to be enlarged is crossed by squares. The same number of larger squares are drawn on the chlkboard, and the corresponding parts of the small picture are drawn on the chalkboard, square after square.

4. The Pantograph:

It is an instrument for the mechanical copying and enlarging of pictures, diagrams, etc. upon any desired scale. In it there is a piece of chalk on one side and a pointer on the other. The small picture ad the pantograph can be fixed on the chalkboard. When the picture is traced by the pointer, the chalk-side of the pantograph will drawn the picture on the chalkboard to the desired size.

5. The Hidden Drawing Method:

By preparing in advance a series of related or sequential drawings, the teacher can describe and expose one stage at a time by using a burlap curtain or big sheets of papers to hide the other illustration. Besides utilizing the "psychological moment", this method also helps to focus students attention on one thing at a time.

Q. Free and Inexpensive Materials:

Nowadays, there are available great numbers of pamphlets, charts, photographs, slides, filmstrips, samples, models, booklets, and many other types of materials which are produced and distributed free of charge or for a very low cost by industrial concerns for use in schools.

A good number of these materials has a good or excellent teaching value with the advertisement for the firm producing it being unobjectionable. Such materials are frequently rich resources both because of their attractive format and composition and their timeliness.

Many catalogues and educational magazines for locating and naming free curricular materials are available. A teacher needs only write to the company and he will be sent loads of materials in class quantities.

Some examples of these catalogues are as follows:

1. Educators' Index to Free Materials, published annually by Educators Progress Service, Randolph, Wisconsin, gives an annotated list of free charts, films, maps, exhibits, etc.

2. Free and Inexpensive Learning Materials, published occasionally by the Division of Surveys and Field Services, George Peabody College for Teachers, Nashville, Tennessee, lists selected pamphlets and other materials by topics.

The following journals also include a section on free and inexpensive materials:

1. NEA Journal, published, by the National Education Association, Washington, D.C.,

2. Scholastic Teacher, published by the National Service for the Teaching Profession, New York 36, N.Y.

3. Educational Screen, published by the Educational Screen, Inc., Illinois.

4. Teaching Tools, published by Ver Halen Publishing Co., Los Angeles 38, California.

Many industrial concerns which utilize chemistry, issue free and inexpensive materials. Some examples of these concerns are:

1. Bakelite Co., A division of Union Carbide and Carbon Corporation. Room 1604, 300 Madison Ave., New York 17, N.Y.

2. General Electric Co., Public Relations, Schenectady 5, N.Y.

3. Shell Oil Co., 50 W 50th St., New York 20, New York.

4. Sheaffer Pen Co., W.A., Public Relations Dept., Fort Madison, Iowa.

5. Firestone Tire and Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio.

6. Electric Storage battery Co., Industrial and Public Relations Dept., 42 South, 15th st., Philadelphia 2, Pennsylvania.

7. Aluminum Goods Manufacturing Co., Manitowoc, Wisconsin.

8. U.S. Atomic Commission, Educational Services, Washington 25, D.C.,

9. Vita Food Products Inc., 644 Greenwich St., New York 14, N.Y.

10. Silver Burdett Co., Research Service Dept., 45 East 17th St., New York 3, N.Y.

CHAPTER XI

CONTENT OF THE MODERN CHEMISTRY CURRICULUM

Chapter V stated the present-day chemistry curriculum in the secondary schools of Iraq and pointed out its defects, lacks and shortcomings. Practices which can improve the existing curriculum were suggested, either directly or indirectly, as the inadequacies of the curriculum were considered. This chapter is a continuation and integration of those suggestions. The considerations which follow are those which are deemed essential by the writer.

A. What Is the Modern Concept of the Curriculum?

A present view of the curriculum is that it consists of all the educative experiences which are provided for the students under the conscious guidance of the school.

A good curriculum is that in which the experiences provided for the students are so selected and organised that they achieve the objectives of the school, that is, help to develop the students' behavior to an increasingly mature and intelligent level.

This conception differs from the older idea of the curriculum as a body of subject matter. Just as the assigned lesson was the basic unit in the older definition, so an "experience" is the unit in the new.

In this modern view, the curriculum is not confined to the classroom, but flows out into the life of the school and beyond the confines of the school building . The design of the curriculum is a function of the whole environment of the learner, not just that of the generalized aspects of the cultural heritage. Recreation, health, creative activities, home adjustment, problem-solving and other activities are all taken into consideration. In short, the curriculum is concerned with the broad aspects of the student's life. This modern concept of the curriculum is more realistic than the concept formerly held, because it is tied down to the learner's problems, needs, interests, social and physical environments as well as demands of the culture.

Under this concept of the curriculum, the trend is towards increasing the emphasis on:

1. Making students participate in various aspects of their learning activities.

2. Making students learn through experience.

3. Responding to student's needs, problems, and interests.

4. Recognizing the learning process.

5. Recognizing individual differences.

6. Making the curriculum problem-centered.

7. Integrating learning into larger wholes instead of fractionating it.

According to this new concept of the curriculum the chemistry curriculum should be considered as all the educative experiences in chemistry which are provided for students under the conscious guidance or the chemistry teacher. A good chemistry curriculum is that in which the experiences are so selected, organised and administered that they lead to the achievement of the objectives of chemistry teaching which are discussed earlier in chapter VII.

As mentioned on p. 86, experiences can be acquired through direct, vicarious, or verbal media.

Therefore, in this new concept of the chemistry curriculum direct experiences such as field trips, laboratory work, demonstrations and the like, are a part of the curriculum.

Similarly, vicarious experiences such as motion picture films, slides, pictures, and models, are also considered as an integral part of the curriculum.

Also, experiences conveyed through the verbal symbols such as the materials contained in the textbooks, in news articles, in lectures of resource people on various aspects of chemistry, and in biographies of chemists and their works when heard or written by the student are also valuable aspects of the chemistry curriculum provided, they are meaningful (i.e., backed by enough direct experiences to serve as a basis for interpreting them.)

Further, experiences in the chemistry club are not"extra" but a part of the curriculum, andtherefore, they are "co-curricular".

Therefore, when building a chemistry curriculum all these methods, materials and activities should be taken into consideration and should be integrated inthe chemistry curriculum.

It is evident that the content, or experiences included in the chemistry curriculum should be an outgrowth of the modern objectives of chemistry which are discussed in a previous chapter. The experiences provided in the chemistry curriculum should not be merely aimed at making students acquire subject matter. Although subject matter is important, it is not an end in itself. Teachers, curriculum builders and supervisors, should continuously ask themselves, "How could this subject matter be used to enable students to operate on an increasingly mature level?"or "What subject matter should we include in the curriculum and how shall we teach it so that our students may have skill in problem-solving, scientific attitudes, and functional understandings?" Only when subject matter is scrutinised in this way, can it lead to proper student development.

Therefore, the curriculum should include a wealth of experiences, which are especially designed to develop the functional understanding of facts and principles of chemistry. Also, it should include a wealth of activities designed for use in developing the skills and attitudes associated with the scientific method of problem-solving.

B. <u>Can this Modern View of the Curriculum Be Implemented in Iraq?</u>

1. Obstacles

The implementation of this modern view of the curriculum is more easily spoken of than actually put into practice . Many obstacles in Iraq stand in the way of implementing it. The following are examples of such obstacles:

a. Teachers are not trained enough to be able to put into practice this modern view of the curriculum. For example, teachers are not trained in the scientific method of investigation. Therefore they cannot be expected to follow a problem-solving approach in their teaching.

b. Inadequacy of facilities such as laboratories, chemicals, moving picture projectors or other projectors. Inadequacy of facilities for such purposes as darkening and lighting rooms, etc.

c. The rigid government control reduces the work of the teacher to mere covering pf subject matter and enforcing of regulations and instructions.

d. Students, teachers, parents, administrators, supervisors, and the Ministry of Education are accustomed to the older type of curriculum. Any attempted change will surely have to fight against the inertia of older habits and practices.

e. College requirements must be greatly changed and government examinations must either be abolished or reduced to minimum essentials if any change to the modern type of curriculum is to be attempted.

The next chapter, however, will deal with ways of working to overcome these difficulties so that the curriculum may be improved .

2. Needed Research

Implementing the new view of the curriculum in Iraq cannot possibly be done by blindly adopting a certain chemistry curriculum practiced in the United States or elsewhere.

The content and practices of the chemistry curriculum should be based on:

a. Research studies aimed at showing the psychological and sociological characteristics of students in the secondary schools of Iraq, and their needs, problems and interests.

b. Research studies to reveal the demands of modern living on the students who are growing in the present cultural mixture of Arabic and Western cultures.

c. Research studies to investigate the needs of the country, its industries, future plans, and potentialities.

d. Survey to reveal local needs and community resources in the various parts of Iraq. Such resources as industries, products, places of chemical interest, resource people, etc. should be located and utilized to vitalize and improve the curriculum.

The above-mentioned types of studies are, in fact, necessary for the whole curriculum of the schools in Iraq. Actually, change and improvement in the chemistry curriculum should be an integral part of a country-wide plan of curriculum improvement.

The above-mentioned types of studies are still lacking in Iraq. Such research problems may be the field of one or more Ph.D. dissertations.

It is, therefore, evident that to determine the content of the chemistry curriculum, (or the curriculum of any other subject) in detail, is a problem which needs many studies and the cooperation of many people. Perhaps the best procedure is to form a committee of curriculum experts, science education specialists, superviors, and chemistry teachers. All these people should cooperate to determine the chemistry curriculum in the secondary schools of Iraq.[1] It is especially necessary to incorporate teachers in such work, for they are valuable résource people. Because of their continued contact with the students, they know a great deal about student's interests, concerns, needs and problems. Their contribution is a wealth which should not be everlooked.

3. Some Suggestions Regarding the Chemistry Curricu

It is clear now that the determination of the chemistry curriculum for the secondary school of Iraq is certainly out of the limited scope of this thesis, which is mainly interested in effective methods and materials which can vitalize and enrich the chemistry curriculum.

However, the foregoing sections of the thesis clearly show the educational creed of the writer regarding the chemistry curriculum. The writer believes in teaching chemistry for its utilitarian value, and a subject through which students could be trained in the scientific method of thinking and the scientific attitude. The writer further

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1. This procedure is suggested and fully explained in the following reference: Association for Supervision and Curriculum Development, Action for Curriculum Improvment, Washington: The Association, 1951.

believes that chemistry should not be taught merely as a college preparatory course. Only some of the secondary school graduates will go to college. For the rest of them the course will be of no use, unless it is taught for a broader purpose. Hence with these students, we are presently violating a principle of democracy; we are doing them an injustice.

Because students in Iraq are taught only how to manipulate symbols, to show proficiency in definition of atomic weights, valences, and in working out mathematical problems in chemistry, they are not proceeding in the direction of the modern chemistry objectives.

This need not be the case. Chemistry in our secondary schools could be made more practical and functional and more conducive to proper student development. Our chemistry curriculum can be greatly improved if curriculum builders, supervisors, and teachers place the center of attention on the life needs, interests, and life problems of the student as determined by studies of the type mentioned before. If the content of the curriculum is selected in the light of those guides, then the curriculum will not be detached from the stream of life of the students for whom it is constructed.

Let us now suppose that a committee of curriculum specialists, supervisors and chemistry teachers is formedto determine the chemistry curriculum. Out of his experience in teaching or supervising chemistry in the secondary schools of Iraq, a member might suggest the following general topics only as examples of topics which seem to be essential for our secondary school students.

(These topics are only suggestive and are by no means exhaustive. They are listed below with no sequential order in mind):

1. The chemistry of petroleum: This is deemed essential because petroleum is the major source of revenue for Iraq and it is a determining factor in the social-economical-political affairs of the country. Further, many vocations are related to this industry. Due emphasis and space should be devoted to this topic in the chemistry curriculum.

2. Atomic structure, energy and peacetime uses. This is a significant topic for our secondary school students since it is an area of knowledge which is affecting every nation in the world.

3. The chemistry of food and nutrition, food preservation, canning industry and similar related topics.

4. The Chemistry of soil, fertilizer, and chemicals used to combat plants parasites and similar topics. This is especially important since Iraq is still an agricultural country.

5. Chemistry as related to health. This includes such topics as drugs, normal bodily functions, antiseptics etc.

6. Chemistry as related to textiles.

7. Chemistry of cosmetics as tooth powders, hand lotions, creams etc. This is especially recommended as an

area for recreational activities.

8. Chemistry as related to industries such as match, glass, tanning, cement, brick, mortar, gypsum, sugar, and so forth. The above-mentioned industries are especially important because they already exist in Iraq. Potential industries which could be developed in Iraq must also be given due emphasis.

9. Other topics such as photography, inks, dyes, fuels, etc. may be included as well.

However these topics are not to be taught separately as such. Rather they should be integrated into a meaningful context. Facts, concepts, and generalizations of chemistry can be abstracted from experience on such topics. As students develop a broad experimental background, it is highly desirable, and in fact necessary, that they organize their knowledge of facts, concepts, generalizations and applications on some systematic basis so that they will be able to carry over this knowledge to new situations, to see the inner relationships that exist among facts, concepts and principles and to interpret and understand new knowledge as it is encountered in the future. Students' experiences in chemistry should be developped into a fuller, richer and more organized form; a form which approximates that in which subject matter is presented to the skilled specialist in the subject.

Moreover, in the chemistry curriculum there should be provision for local necessities and differences. The curriculum may contain general essentials for all students in area for recreational activities.

8. Chemistry as related to industries such as match, glass, tanning, cement, brick, mortar, gypsum, sugar, and so forth. The above-mentioned industries are especially important because they already exist in Iraq. Potential industries which could be developed in Iraq must also be given due emphasis.

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Moreover, in the chemistry curriculum there should be provision for local necessities and differences. The curriculum may contain general essentials for all students in

Iraq and at the same time it may provide for local needs. The chemistry curriculum in northern parts where the weather is cold may emphasize the experiences on the topic of fuels. In Mosul, Kirkuk and Basra the curriculum may emphasize and make wide use of petroleum fields and refineries in the vicinity. In each locality, students may study agricultural and industrial problems or other types of problems which are related to the students' immediate environment. This is essential for three reasons:

1. Students will be better adjusted to their environment and more sensitive to the social needs and problems in their community.

2. By so doing, the school contributes to the social development of the students and may also contribute to improving conditions in the community.

3. The curriculum will be vitalized and enriched by using the available community resources. Students in Mosul may utilize the sulfur springs, those in Kirkuk may utilize the petroleum fields and refineries, those near Basra may utilize the salt deposits in their locality, and those near the persian Gulf may utilize the water of the sea for many instructive and interesting experiments.

Up till now, a number of experiences in chemistry considered as desirable for secondary school students in Iraq have been suggested. Perhaps, it may be objected that all these experiences, if taught in the manner suggested in the thesis, would require too much time. But, if we only recognize that the present-day curriculum in Iraq contains a great deal of detailed and theoretical elaboration of subjects, which remain in the minds of the students as inert pieces of information, then it will be obvious that space and time could be found for these comparatively more valuable experiences.

Together with Noll[1], the writer believes that detailed description of individual metals, their metallurgy, compounds, and uses should largely be abbreviated to a general treatment in a chapter or two in a textbook, and details of non-metals should be omited, thus reserving space to more important topics which are of vital value to students' lives.

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1. Noll, V.H., The Teaching of Science in Elementary and Secondary Schools. New York: Longman Green & Co., 1942, p. 60.

PART 1V

IMPROVING THE CHEMISTRY CURRICULUM

CHAPTER XII

WAYS OF WORKING TO IMPROVE THE CHEMISTRY CURRICULUM IN IRAQ[1]

Introduction

The various inadequacies and deficiencies of educational practices in Iraq as regards objectives, methods, materials, and content of the chemistry curriculum in the secondary schools were discussed in the first part of the thesis. In later parts, the modern educational theory and practice as regards objectives, methods, materials, and content were also discussed.

The purpose of this chapter is to show how to bridge the gap between the actual situation of chemistry teaching in Iraq and the modern concepts and practices of chemistry teaching. It goes without saying that the change in teachers' thinking and practices; the shift from the older conception of the curriculum to the new will not come over-night. Change has to be gradual; evolutionary rather than revolutionary. Moreover, improvement has to be on many fronts and the result of the cooperative effort of many people and agencies. Each of these agencies can contribute and give impetus to the improvement of the curriculum.

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1. For the purpose of securing a good foundation for this chapter, the following references were read:
   a. Association for Supervision and Curriculum Development, Action for Curriculum Improvement, Washington, D.C.: The Association, 1951, Yearbook.
   b. Miel, A., Changing the Curriculum. New York: D. Appleton-Century Co., Inc., 1946.

(Contd)

Therefore, the following will be discussed:

1. What can the teacher do to improve the curriculum ?

2. What can the Ministry of Education do to improve the curriculum ?

3. What can the teachers' colleges do to improve the curriculum ?

4. What can the supervisor and the curriculum worker do to improve the curriculum ?

A. What can the Teacher Do ?

The current interpretation of the curriculum — that it consists of all the educative experiences that come under the guidance of the school — places tremendous importance upon the teacher as a curriculum builder. To the extent that the teacher is competent in designing and providing worthwhile and appropriate experiences, the curriculum of his students will be fuller and more effective and meaningful.

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1. c. Alberty, H., Reorganizing the High-School Curriculum. New York: The Macmillan Co., 1955.
   d. Saylor, J.G., and Alexander, W.M., Curriculum Planning, for Better Teaching and Learning. New York: Rinehart and Co., Inc., 1955.
   e. Benne, K.D., and Muntyan, B., Human Relations in Curriculum Change. New York: Dryden Press, 1952.
   f. Sharp, G., Curriculum Development as Re-education of the Teacher. New York: Bureau of Publications, Teachers College, Columbia University, 1952.
   g. Spears, H., The Emerging High-School Curriculum. New York: American Book Co., 1948.
   h. Leonard, J.P., Developing the Secondary School Curriculum. New York: Rinehart and Co., Inc., 1955.

In Iraq where the curriculum is rigidly enforced and where teachers are required to cover the whole curriculum in detail, the teacher need not be in a desperate situation. If he really wants to enrich and extent the curricular experiences of his students he can do such things as the following:

1. He can provide his students with valuable experiences through such devices as laboratory work, demonstrations, field trips and student projects.

2. He can improvise materials and equipment when these are not available. Many of the materials which the teacher needs are right at his disposal although he may not know them. A rusty piece of iron is a valuable material for a chemistry class. A crushed piece of an automobile glass is also another valuable material which illustrates how this kind of glass is made for the safety of people. The aluminum, tin, sulfur, crude oil and its various derivatives, the chrome coverings of articles, sodium bicarbonate, copper fulfate, milk, butter, honey, sea water and a host of similar materials which are available at drug stores, in the market or at home, serve as illustrative materials which the teacher can utilize to provide valuable experiences to his students. The teacher also can improvise apparatus and equipment when they are not available. Empty medicine tubes can be used as test tubes. Empty bottles, glasses and similar household materials can be utilized by the chemistry teacher

for many purposes. Many an apparatus canbe improvised. Examples are: an apparatus to show the degree of ionisation, an apparatus to show electroplating, an electolytic cell, an apparatus for distilling water and so forth. The teacher can involve students in such work. He may designate the construction of an apparatus, or the collection of materials as student-projects.

3. The teacher can utilize the community resources to enrich and extend the experiences of his students. Possibilities for field trips and excursions are seldom fully explored. Sulfur springs and tanning industry at Mosul, cement, matches, soap, textile and brick industries at Baghdad, petroleum fields at Mosul, Kirkuk and Basra are but examples. Many teachers, perhaps, are not aware of what the community has to offer. Consequantly, a survey of each community should be made tp furnish teachers with information about the services and materials that are available. This survey can be done by the supervisor or a committee of teachers. Interested laymen may also participate in such work.

Another rich resource may be found in resource persons, many of whom can bring to classes living experiences which are of untold value. Physicians, dentists, specialists in various industries as tanning, cement, matches, soap, textile and the like, can be used by the teacher to vitalize the student's curriculum. Through interviews with them, through trips to their places of work, and through their services in schools and classrooms, pupils and teachers may benefit greatly.

4. The teacher can improve the learning environment inside the classroom by such devices as bulletin board arrangements, exhibit corners, reading corners, posters, and other free and inexpensive techniques.

5. The teacher can arouse his students' interest in the topics studied by following the techniques discussed on pp.108-109.

6. The teacher can discover and guide his students' talents, observe their limitations, promote healthy mental and psychological attitudes, plan and guide their learning activities to the end that the objectives of education in general and of chemistry in particular may be achieved.

However, if the teacher is to be able to do such creative and effective work, he has to be educated for it. The teacher is the key figure in the learning process. He has a tremendous effect on the students' learning. Therefore, curriculum improvement is essentially brought about by improvement in teachers' education. To the extent that the teachers' resources are extended, enriched, and utilized, the curriculum of his students will be fuller and more meaningful. It follows, then, that the central matter in curriculum improvement lies in the proper education of teachers.

B. What can the Ministry of Education do?

Because education in Iraq is under the exclusive control of the ministry of Education, a great share of the responsibility for educational improvement in schools lies with the Ministry. Improvement can be achieved when the Ministry does the following:

1. Adopt a modern chemistry curriculum as has been explained in the previous chapter. There, the curriculum has been defined as the body of experiences provided to students under the guidance of the school. The reader might have discovered that no distinct separation was made between the content of the curriculum and the method through which the content is conveyed to students. This implies that both the content and the teacher's methods should be improved . How to improve the content was explained in the previous chapter. It may be added here that the curriculum also will be improved when committees of teachers, curriculum workers, supervisors, and science education specialists work together to correlate each unit of the chemistry curriculum with experiments, projects, community resources, films, filmstrip, pamphlets, etc. Other methods of improving the curriculum will be considered later in this chapter.

2. Provide facilities such as laboratories, chemicals, apparatus, projectors, films, slides, etc., to whatever extent is possible. How these materials would help a teacher improve his work was explained on pp. 112-116 .

It may be added here that the whole job of education boils down to communication of facts, concepts, principles, skills, attitudes, and patterns of behavior. Most chemistry teachers depend almost exclusiveley on verbal symbols for communication. Words are communicative when the students have enough experiential background. Audio-visual methods and materials are essentially effective tools of communication which appeal to sense perception. Hence, audio-visual materials will put the teacher in a better position to communicate more efficiently. They will also shortenthe time necessary to communicate ideas to students. A great deal of verbalization can be avoided by using a single picture, which can be grasped, at a glance, much more clearly and effectively than hundreds of words. Communication is facilitated when there is something seen, handled, smelled , or tasted. It is needless to say that audio-visual methods and materials are not a panacea for all the ills of education in Iraq. Nor are they ends in themselves. Rather, they are means which facilitate communication. Further, these methods and materials can be overused or misused. Their proper utilization is the most important factor in their effectiveness. In order to use them properly, teachers must be educated in their in their proper use. This can be carried on through in-service education and through teacher-education in colleges.

3. Utilize dissatisfaction to effect curriculum improvement. People are usually reluctant to change a s situation so long as they are satisfied with it. Dissatisfaction with existing conditions seems to be a prerequisite for intentional change. The present situation in the secondary schools of Iraq is one in which sources of dissatisfaction are many. Examples are: overloaded curriculum; the non-functionality of the curriculum; lack of materials, equipment and facilities; lack or poorness of laboratories; superficiality of what the students actually gain out of the chemistry courses; failure of the secondary school program to prepare students for social responsibilities, for effective living, or for a vocation; discipline problem and the like.

Teachers of chemistry are always confronted with these and similar problem which serve as sources of dissatisfaction. However, teachers'feelings of dissatisfaction about such problems may be hazy. To a great number of them, such problems are obscure and not well-defined.

The process of utilization of dissatisfaction as a factor producing change is partly one of helping teachers to arrive at a common definition of the situation through analysis of conditions, thus making explicit the maladjustments involved. This process will be largely a matter of converting a vague sense of discomfort and unrest into a strong conviction that certain specific ills should be attacked. The following are some of the methods to arouse and utilize dissatisfaction among teachers for the purpose of improving the curriculum:

a. one effective technique of arousing and utilizing dissatisfaction is to find facts about present situation. Needs, problems, lacks, and deficiencies of present conditions can be revealed by finding facts and statistics about them by utilizing inventories, questionnaires or other methods. Facts and statistics will put under the eyes of the teachers the results of their own methods, practices and provisions. Let us take, for instance, the following problem: chemistry is taught in the secondary school of Iraq as a college preparatory subject. If facts are found regarding how many students among those who took the chemistry course did actually go to college, then teachers will "see" whether this percentage of students justified teaching chemistry for that sole academic purpose. Teachers will realize that their efforts are being wasted and dissipated in a useless way. As a result they will become dissatisfied. They will feel that something should be done about this situation. This is where the role of the Ministry of Education comes into the picture. It can utilize this motivational power of dissatisfaction to effect change in the practices of chemistry teachers. The Ministry can provide curriculum workers and specialists in science education to work with committees of teachers in order to find a solution to this problem.

Another example of how finding facts would produce dissatisfaction is the following:

If graduates of the secondary school who have had the usual chemistry course as a terminal course, are tested for what they retain of chemical facts after two years of their graduation, the results will certainly show the tremendous, proportion of facts that are forgotten. This will show teachers the futility of their own methods in teaching for permanent and useful learning. Dissatisfaction among teachers will be a aroused, and the desire to do something about the situation can thus be created. Again the Ministry of Education can help these dissatisfied teachers in a variety of ways by providing consultant services, supervisors' help, conferences, summer institutes and similar techniques which are aimed at improving the teachers' methods so that effective learning may begin.

b. Another promising approach to arouse dissatisfaction is to <u>study learners, their needs, problems, and areas of living which they should master so that they may be better adjusted and happier</u> . When teachers realize that the practices they follow do not help students meet their needs, solve their problems, and become better adjusted, then teachers certainly will be dissatisfied with their own practices, and a desire to improve their work will be created. A better understanding of the <u>learning process, of the nature of growth, and of the psychology of adolescents</u> should motivate teachers to change many of their formal and inefficient practices.

The Ministry may get teachers to understand the above-mentioned areas through such techniques as the following:

1. By putting due emphasis on these areas of study in the teachers' college (which is under the control of the Ministry).

2. By providing for in-service teachers summer institutes, summer courses, conferences and workshops.

3. By providing in-service teachers with bulletins, pamphlets, results of research, etc., to enlighten them on various areas of significance to their work.

Another helpful procedure is to show and discuss with teachers films about developmental psychology, discipline, individual differences, characteristics of the adolescent period, problem-solving approach to learning, how to conduct a field trip, how to use the chemistry laboratory for effective learning and so forth. Such films will create insight into the proper approach to teaching and certainly will help teachers change many of their practices.

c. A third approach is to utilize some dissatisfaction felt by people associated with the school to motivate interest in group problem solving. In a school where chemicals, materials, and equipment are lacking, teachers of chemistry, physics, and other teachers together with the principal and local directors of education may cooperate to locate community resources, to make or to find money to purchase material and equipment. Let teachers start working on problems that concern them first, minor as they may be. This will create interest in working for the solution of other problems. Teachers will be interested in working to improve conditions in the school when they feel that their contribution counts for something, when they see that their suggestions are respected and are taken into consideration. In this way a high degree of morale also will be maintained among teachers.

It is regrettable that this aspect is neglected in Iraq. This is manifested in the following example. The Ministry of Education requires chemistry teachers to send in their suggestions and criticism of the existing chemistry curriculum nearly every year. However, when the writer asked the Ministry to send him a few samples of these criticisms and suggestions, he was told that they "are not available". Apparently, they have been discarded without the awareness that a wealth of human sources of motivation, which could be utilized constructively has been dissipated. These suggestions and comments on the chemistry curriculum actually could be used as valuable resources. By carefully studying them, the Ministry of Education may understand the feelings of chemistry teachers, their problems, and the sources of their dissatisfactions. If the Ministry then reacts positively towards these suggestions and comments, teachers will be inclined to cooperate with the Ministry in working for curriculum improvement. One favorable method of reacting positively to these suggestions and criticisms is to form a conference of chemistry teachers to discuss these criticisms and find ways of putting the worthwhile ones into practice.

4. The Ministry should provide opportunities for teachers to grow in professional efficiency. It has come to be widely accepted that the primary means of changing the curriculum is through changing teachers. Teachers usually do the best of which they are capable; as a rule they do those things which they believe are important and relatively of greatest value. They cannot change their practice like taking off an old coat and putting on a new one. They must have a conviction that change is desirable, and they must learn how to guide the new curriculum as proposed. In-service education helps teachers develop this essential basis for improving practice. Hence, it is a main avenue to curriculum improvement. However, in-service education of teachers is not an easy matter. It means that teachers are to be helped to grow in understanding of the teaching-learning process; to acquire new professional habits and insights; to develop an understanding of students' needs, interests and problems; and to be helped to follow a flexible plan which allows students greater initiative, more responsibility, more participation, and to guide students' self-directed activities. The total approach of teachers has to undergo change. In-service education may be achieved through the following means:

a. Workshops where curriculum worker, supervisor, and teachers work together on planning for curriculum improvement. These workshops can be held at Mosul, Baghdad and Basra. They can be either during summer or during the school year. Studies in curriculum improvement indicate that one effective method to help teachers improve is to begin with matters that concern them such as how to make chemistry useful to students, how to guide students activities in the laboratory, how to improvise equipment and facilities, and the like. It is, therefore, evident that the workshop program should not be exclusively planned and administered by the Ministry of Education. Rather, the program should be the outgrowth of efforts to help individual teachers. Thus they should participate in planning at least some of its activities. The program of these workshops may include activities which are as varied as the problems which teachers may meet in their day-to-day work with the students. Teachers may learn in these workshops how to operate motion picture projector, opaque and slike projectors; how to make charts, diagrams, posters, exhibits, and bulletin arrangements; how to plan and carry out field trips; how to guide students' activities in the laboratory, in the club, or in the classroom, etc.

b. Conferences which can be of two, three or more days duration. They may be held during mid-year vacation or during summer. These conferences can be Liwa'-wide,[1] in which case

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1. A Liwa' is a county. Iraq is made up of 14 Liwa's.

they may be held at the largest city in the Liwa' as in Mosul, Kirkuk, Sulaymania, Baghdad or Basra. They also may be country-wide, in which case they would probably be held at Baghdad only. When teachers have to travel to the place of the conference, the Ministry should pay for their travel, lodging and boarding expenses. Topics can be derived from problems met by teachers or from general problems of education in Iraq which have an effect on chemistry teachers' work such as the problems discussed in part I of this thesis. Audio-visual methods and materials may be discussed in such conferences as well.

c. Summer Institutes: Actually, the Ministry holds such institutes every year. Lodging, boarding, and travel expenses are paid to the teachers. However, most of these institutes are held to improve teaching of English in Iraq. Such institutes should be held also for other subjects. Further, a more practical program should be offered in them. Actual problems as related to chemistry teaching in Iraq, should be studied and tackled in these institutes. It is very essential to train teachers in these institutes in the proper utilization of the laboratory, demonstration, field trip; in the proper sponsoring of chemistry clubs; in proper utilization of films, film strips; in operation of equipment and projectors; and in the production of audio-visual materials such as charts, posters, graphs, slides, filmstrips and recordings. Teachers should be allowed to select some of the content of these institutes. They should be given opportunity to solve the problems which they themselves consider urgent.

d. Television : As mentioned before, Iraq is the first Arab country that has television facilities. Fortunately, these facilities have been obtained for educational purposes. How television may be used to enrich the chemistry curriculum, was explained on pp. 149-150.

Television could possibly be used effectively for in-service education of teachers. Special programs can be sponsored by the Ministry of Education. Such programs can be planned and televised to chemistry teachers. Examples of such programs are the following:

1. How to conduct a field trip: A chemistry class may be taken in a field trip by a competent teacher. The whole procedure from the beginning to the end can be televised for other chemistry classes to see and adopt.

2. How to administer laboratory work of the type that trains in problem-solving and the scientific attitude. Again effective and worthwhile procedures can be televised out of a laboratory full of chemistry students being guided by a competent teacher or a science education specialist.

3. How to use the demonstration method for training students in thinking. A skillful demonstrator working with a group of students may inspire teachers over television more than many lectures would do.

4. Proper utilization of moving pictures or any other

audio-visual tool in chemistry teaching is another example of a possible television program. A film may be used with a group of students by a competent teacher, and the whole procedure televised. This, certainly, would help teachers to understand the proper teaching techniques when using films.

5. Teacher-education films showing various teaching techniques and concepts such as problem-solving, wider concept of the method, discipline, etc., may also be televised to teachers.

Many other uses of television for in-service education of teachers could be found. They could be televised to teachers at convenient scheduled times.

At present, television sets are unlikely to be made available in every school, because of cost limitations. One possible solution for this problem would be to put television sets at Teachers' Association Clubs in every city.

In short, availability of television in Iraq presents a golden opportunity for effecting a constructive program of in-service teacher-education as well as other useful educational services. It only needs to be planned and used properly.

e. <u>Bulletins</u>. These can be provided to teachers by the Ministry. Bulletins are useful for they bring together a variety of information in an easily accessible form. Such topics as teaching methods, audio-visual materials, units of study, and similar topics may be treated in them.

f. Results of Research studies about different phases of the curriculum about methods, and about materials may be provided to in-service teachers. As will be explained later, research studies could be carried out by the teachers' college. The results of these research studies may, then, be reported to teachers to benefit from and apply in their own situations.

g. Guides which accompany films, filmstrips, slides should also be made available to teachers. Such guides will help teachers in the proper utilization of the audio-visual materials provided to them. Such guides also may be in the form of possible field trips in the community and how to utilize them properly.

h. Correlations: These suggest various materials which could be used when teaching a certain unit. This kind of help to chemistry teachers is very necessary. Teachers who have enough ingenuity and resourcefulness to find for themselves and improvise suitable materials to be used in correlation with each topic or unit of the curriculum are actually few in number. The rest of the teachers need constant help and suggestions.

Actually materials that could be suggested on a single unit are many. The teacher may then choose those materials that suit his class best. The following list of materials will serve as an example of the vast number of materials that could be suggested on a simple unit. The unit for which the following materials will be suggested is on structure of the atom and the atomic energy:

Motion Pictures

1. Operation Greenhouse, 25 min., color, United World films, Inc.

2. Atomic energy, 11 min., b+w, Encyclopedia Britanica Films.

3. The Atom and Industry, 12 min., b+w, Encyclopedia Britanica Films.

4. A For Atom, 15 min., color, Free Loan, General Electric Corporation.

5. The Atom and Medicine, 12 min., b+w, Encyclopedia Britanica Films.

6. The Magic of the Atom Series, 13 films, each 12½ min., b+w, Handel Film Corporation. Titles: The Atom and the Doctor, The Atomic Alchemist, Atomic Furnaces, The Atomic Greenhouse, The Atomic Pharmacy, The Atomic Zoo, The Atom in industry, Atom Smashers, The Eternal Cycle, The Master Slave, Protecting the Atomic Worker, Security, Tagging the Atom.

7. Radioisotopes in General Sciences, 46 min., b+w, United World Films, Co. Inc.

Filmstrips

1. Atom at Work, 52 frames, color, Society for Visual Education, Inc.

2. Making Atomic Energy Help Mankind, 45 frames, b+w, Popular Science Publishing Co.,

3. Man's Use of Power, 48 frames, b+w, Popular Science Publishing Co.

4. Peacetime Uses of Atomic Energy, 20 frames, Sound, b+w, Lewellen's Productions.

Disc Recordings

1. The Search for Atomic Power, 30 min., Westinghouse Electric Corporation.

Pamphlets

1. The World Within the Atom, Westinghouse School Service.

2. Adventures Inside the Atom, General Electric Corporation.

3. Dagwood Splits the Atom, U.S. Atomic Energy Commission.

4. Control of Radiation Hazards, U.S. Atomic Energy Commission.

5. Putting Atom to Work in Your Plant, U.S. Atomic Energy Commission.

6. Atomic Energy is here to Stay, U.S. Atomic Energy Commission.

7. The Atom Turns Healer, U.S. Atomic Energy Commission.

8. Living With the Atom: A Teaching Unit on Atomic Energy. Albany, New York: University of the State of New York Press, 1952.

Other Materials

1. Nuclear Physics Charts. Westinghouse School Services.

2. Stockle Molecular Demonstration tube, (Cat. No.77725) Central Scientific Co.

3. Molecular Models Set, M.C. Welch Scientific Co., 1515 Sedgwick St., Chicago, Ill.

4. Many students-projects could be suggested on this topic. Examples are: models of atoms of various elements such as lithium, hydrogen, and the complex uranium atom; a cloudd chamber; an atomic power plant model; a model of a cyclotron; biographies of Dalton, Bohr or other scientists, etc.

5. Many experiments, demonstrations, and readings could also be suggested on this topic.

C. What Can the College Do?

The Higher Teachers'Training College at Baghdad can participate in improving the curriculum in the secondary schools in general and the chemistry curriculum in particular by doing the following:

1. Offer a good teacher-education program. Much attention should be given to teacher-education if any curriculum improvement program is to be successful. Graduates of the Higher Teachers' College should be equipped with those competencies necessary to improve existing situations in schools and to solve educational problems of Iraq satisfactorily. Teachers should be grounded realistically in the problems, inadequacies and deficiencies which they are going to meet in schools. They must also be taught how to grapple with these problems and improve these situations.

2. Action research[1] may be performed at the Gharbia Intermediate School, the Higher Teachers' Training College's model school at Baghdad. Practices that prove successful and compatible with existing situations in Iraq may then be introduced gradually into other public schools.

3. Summer courses may be offered to teachers to increase their efficiency. Teachers who take such courses may be encouraged materially by the Ministry by giving them an increment in their salaries.

4. Consultant service may be offered to schools. These consultants may confer with individual teachers, with

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1. Action research is an individual research by the teacher on a small scale conducted as a part of the regular class activities.

teachers of a school or of many schools. Problems met by these teachers such as laboratory deficiencies or techniques, difficulties met when following a problem-solving approach and the like may be discussed with the consultant.

D. What can the Supervisor and the Curriculum Worker do?

The curriculum worker is a specialist who is interested in improving the school's program. Both the curriculum worker and the supervisor may cooperate to help the teachers improve their methods and practices. The following are some of the methods through which the supervisor and the curriculum worker may help the teachers:

1. Teachers' guidance

If the teacher is to modify and change some of his older approach and habits, he should be given much help and guidance. It is the job of the curriculum worker and the supervisor to guide and help the teacher . It has been the habit of the supervisors to come to the school in order to put an " approved " or a "disapproved" on the teachers' record and to dictate to them. Teachers do not feel free to communicate their feelings to inspectors. They do not feel free to ask for help, suggestions, or solutions of problem. Teachers think that this would "show their weakness ". The fact that the inspector's report may cause a teacher to be fired or shifted to an uncomfortable school makes free communication between them difficult.

Supposedly, an inspector or a curriculum worker is a guide. His aim is to help the teacher to discover through discussion and analysis, new insights into the profession and into the needs of his students. When the teacher tries the new ideas in the classroom and they prove succesful, then the teacher has begun to grow. The curriculum worker and the supervisor should attend the teacher's classes in order to see how he is putting the new ideas into practice, and to help him improve in the areas where he needs improvement. Both the supervisor and the curriculum worker are resource persons. They should make themselves available to teachers whenever they are called upon for help. Further, they should establish rapport with the teachers. Perhaps one good method is to begin by saying to teachers: " I am here to help you; to work with you to improve the conditions in this school; put me to work, give me suggestions. What are the things in which you want me to help you?"

Gradually, theteachers will understand that the supervisor or the curriculum worker has not come to dictate to them, to fire them, or to shift them to other schools. Consequently they will want to cooperate with him for the purpose of improving students learning. Meetings of these specialists with teachers should not be sporadic, but should be held at regular times.

2. Demonstrations

The teacher may become convinced of the soundness of a new idea, but he will hesitate to put it into practice . However, supervisors and curriculum workers can help a teacher overcome this hesitation by setting an example. They can provide the teacher with an opportunity to visit a school where this new idea is being practiced successfully such as the model school of the Higher Teachers' Training College. The demonstration classrooms should be large enough to occupy the students at the front and a number of observing teachers at the back. Facilities for performing experiments, projecting films, or for group work should be available. The furniture of such classroom should not be firmly fixed; it should permit quick change and rearrangement.

The supervisor or the curriculum worker himself may take a class and show teachers how new ideas could be put into practice. In a teachers'meeting, one teacher may take on the role(pretend) to teach according to a certain plan. Other teachers pretend to be a students. At the end, the procedure of the acting teacher may be discussed and criticized constructively. This procedure would create insight into the nature of the role.

Such direct experiences for the teacher would encourage him and remove his fear of trying new ideas. To "show him" is much better than to "tell him", especially when it comes to such new concepts as "teacher planning together with his students" or "working in groups" or "problem-solving approach to learning" and the like.

One important problem which is related to demonstrations is the scheduling of teacher's attendance at demonstration schools. Some schools in the United Statesof America, for example, close for a day or more in order to give teachers opportunity to visit demonstration schools. Other means of finding appropriate time for demonstration lessons may be found.

S U M M A R Y

Observation of methods, materials, and content of the chemistry curriculum in the secondary schools of Iraq leads to the conclusion that instruction in this subject is in need of improvement. The objectives of chemistry teaching in the secondary schools of Iraq are hazy, not well reasoned, and actually are paid no heed by the teacher. The method usually followed in teaching chemistry is the " assign – study – recite – test " method. Very little effort, if any, is exerted in the direction of making chemistry functional in the daily lives of the students. Primary emphasis is placed on the memory process and the acquisition of inert bodies of information. The Ministry of Education suggests that teachers follow an inductive procedure, utilize the laboratory, perform demonstrations, use audio-visual methods and materials, and organize a chemistry club. In practice, these suggestions are not followed due to inadequate teacher-education, inadequate facilities, the existence of an overloaded curriculum, and the lack of " know-how " among teachers. The chemistry curriculum taught in the secondary schools is overloaded with facts, details, and unnecessary bits of information. Also, it is not functional, for it mentions facts as abstractions apart from the real life of the students, their needs, problems, and interests. Further, it is static, overlapping, and does not follow a psychologically sound organization.

These are the major defects of chemistry teaching in the secondary schools of Iraq.

It is well-known that learning is motivated by interest, and understanding is aided by visualization. Besides, a curriculum is good and useful to the extent that it helps students to solve their own problems of living in the world of today and tomorrow.

This thesis proposes remedies for the above-mentioned defects. It shows how chemistry in the secondary schools of Iraq could be made more interesting, more meaningful, and more conducive to desirable student growth. It suggests a number of clear, well-reasoned, and widely accepted objectives toward which the chemistry teacher should work with his students. These objectives are in short, (1) functional understanding of facts and principles, (2) skill in scientific problem solving, (3) scientific attitudes, interests and appreciations. These objectives are deemed essential for secondary school students. To quote John Dewey, " The future of our civilization depends upon the widening spread and deepening hold of the scientific habit of mind."

To attain these objectives, a number of audio-visual methods and materials, under which learning goes on pleasantly and efficiently are explained in the thesis. These methods and materials are designed to capture students' interest, and improve their thinking. They provide a tangible basis for learning, hence they help to overcome the verbalism and superficiality that presently characterizes the teaching – learning situation in the secondary schools of Iraq.

It is also necessary to improve the content of the chemistry curriculum. The chemistry curriculum is defined in this thesis as all those educative experiences provided to the students under the conscious guidance of the chemistry teacher. Chemical experiences obtained through direct, vicarious and verbal media are all considered as integral parts of the chemistry curriculum.

Implementation of this modern view of the curriculum in Iraq will encounter many difficulties such as lack of needed research, inadequate teacher-education, inertia of older habits and practices, college requirements and so forth. Many improvements are needed in order to bridge the gap between present-day chemistry teaching in Iraq and the modern view of the curriculum as proposed in this thesis. Improvements may be made on many fronts as the result of the cooperative efforts of the teachers, the Ministry of Education, the Teachers' College, the curriculum workers, and the supervisors.

In any scheme to vitalize instruction, the teacher must always play a leading part. The teacher can extend chemistry out of the realm of pure symbols and equations and into the dynamic aspects of the students' lives. He can improvise materials, apparatus, and experiments, he can utilize community resources, he can improve the learning environment. In short, he can decidedly enrich the experiences provided for the students.

However, if the teacher is to be creative and effective in designing and improvising appropriate experiences for his students, he must be well educated. To the extent that the teacher's resources are extended and enriched, the curriculum of his students will be fuller and more meaningful.

The Ministry of Education can participate in improving the curriculum by providing teachers with facilities, utilizing their dissatisfaction with existing situations to produce change, providing opportunities for in-service education of teachers, such as workshops, conferences, summer institutes, and by utilizing television, providing informative bulletins, publishing the results of research, providing guides to correlate with audio-visual materials, and suggesting activities and experiences which may be used with each one of the units of study.

The college can participate in improving the curriculum by offering a good teacher — education program, carrying out action research, offering summer courses, and providing consultant services to teachers.

The supervisors and the curriculum workers can participate in improving the curriculum by guiding teachers and providing teaching demonstrations.

All these efforts can and should be integrated to improve the experiences of the students in the secondary school of Iraq, so that chemistry may be more conducive to their proper development and more functional in helping them toward greater competence in solving their own problems of living in the world of today and tomorrow.

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A B S T R A C T

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