THE TEACHING OF CHEMISTRY IN THE SECONDARY SCHOOLS OF LEBANON WITH SOME SUGGESTIONS FOR ITS IMPROVEMENT

By

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PREFACE

There appears to be a widespread dissatisfaction with existing conditions in secondary school teaching in Lebanon, and there are many demands for the reorganization of curriculum, methods, and examinations. The results of the Baccalaureat examinations constitute a main factor behind this dissatisfaction and these demands. A preliminary informal investigation disclosed that dissatisfaction is most acute in the teaching of secondary school chemistry. As a secondary school student in chemistry, I experienced some problems in the teaching of chemistry from the student point of view, and I too developed an attitude of dissatisfaction towards it. Teaching chemistry for four years has given me an insight into these problems from the point of view of the teacher.

According to the investigation, the average number of years over which chemistry is taught in the secondary schools of Lebanon is more than three. In spite of the fact that much of Freshman chemistry is a repetition and an expansion of secondary school chemistry, about 30% of the freshman chemistry students, at the American University of Beirut during the years 1951-55, (who had studied in the secondary school of Lebanon) failed the course. The results of the Baccalaureat examinations are much worse. It should be kept in mind that only the best students in the secondary schools of Lebanon usually find their way to

universities. A large proportion of secondary school students terminate their formal education with the secondary school. The teaching of secondary school chemistry as preparation for universities and general examinations has neglected the needs of this terminal group of students.

Since I am a student of both chemistry and education, and a teacher of chemistry for the fourth successive year, I am very much interested in studying the problems facing teachers and students, and in presenting some suggestions for the improvement of the situation.

The present study is restricted to the teaching of chemistry in the secondary schools of Lebanon. I hope that some of the problems raised and some of the suggested methods and recommendations may serve as starting points for the improvement of chemistry teaching in Lebanon. A review of the results obtained should help prospective chemistry teachers become acquainted with some of the realities of the situation awaiting them.

In this investigation, questionnaires, in both English and French, were distributed to students and teachers of chemistry. Copies of these questionnaires may be found in the appendix. These questionnaires were answered by 137 students representing 51 secondary schools in Lebanon. Some of the questionnaires were distributed by hand and others were sent by mail, with stamped self-addressed envelopes enclosed. Out of the 72 questionnaires mailed to teachers all over the country, 22 (30.6%) were returned.

Other teachers were contacted personally, or through friends and students, thus increasing to 41 the number of teacher responses. These represented 37 schools. The names of the schools and the distribution of students and teachers queried are given in the appendix.

In addition to the questionnaires, many teachers and students were informally interviewed for the purposes of this study. Ten schools were visited for the purpose of clearing up points in the questionnaires that were not adequately answered, and for the purpose of creating a clearer picture in my mind regarding the general atmosphere in which the teaching of chemistry is now taking place. These contacts with students and teachers were supplemented by a special study of chemistry students from the secondary schools of Lebanon who were enrolled in the Freshman class of the American University of Beirut.

Many books have been written on the teaching of chemistry and the other physical sciences, and a number of conferences have been held for the study of science teaching. But, as far as I know, the topic of this thesis has not been treated before. It was the lack of investigation dealing with secondary school chemistry teaching in Lebanon that suggested to me the need for an intensive study of this kind.

In addition to the authors of the many articles in the Journal of Chemical Education and the authors of the books mentioned in the footnotes and in the bibliography, I am indebted

to my teachers and professors, to my colleagues in the American Community School and in the American University of Beirut, to my students, to all those who were kind enough to answer the questionnaires, to those officials who made my visits to their schools possible, and to the many persons whose aid and encouragement have contributed to this work. I wish particularly to express my sincere thanks and grateful appreciation to my advisor, Professor Frederick Korf, for his guidance and assistance.

George I. Za'rur

ABSTRACT OF THESIS

Submitted in partial fulfillment for the requirements of the degree Master of Arts in the Education Department of the American University of Beirut, Beirut, Lebanon.

THE TEACHING OF CHEMISTRY IN THE SECONDARY SCHOOLS OF LEBANON WITH SOME SUGGESTIONS FOR ITS IMPROVEMENT

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The present-day aim in the teaching of secondary school chemistry in Lebanon seems to be to prepare students for general public examinations and for higher education. The methods used in this preparation emphasize primarily rote memorization. The needs of a large proportion of secondary school students whose formal education ends with the secondary school are not being considered in this preparation. Moreover, these efforts in preparation for examinations and higher education seem to be highly inefficient judging from the percentage of failure in the Baccalaureat examination and in the freshman chemistry courses of the American University of Beirut. A widespread dissatisfaction with existing conditions in secondary school chemistry teaching proved to be prevalent among students.

In this investigation, questionnaires in both English and French were distributed to students and teachers of chemistry.

Questionnaires were answered by 138 students representing 51 secondary schools in Lebanon. Forty-one responses were received from teachers. In addition to the questionnaires, many teachers and students were informally interviewed for the purpose of the study, and ten schools were visited.

In practice, chemistry is given relatively little emphasis in the Baccalaureat examination. This explains, in part, the lack of enthusiasm and interest shown toward chemistry by secondary school students and teachers preparing for the Baccalaureat.

In the teaching of chemical theory, the questionnaires have shown that a great deal of lecturing and dictation of notes is practiced, with a corresponding emphasis on verbalism and memorization. Laboratory activities when they are not entirely lacking, are more often than not simply demonstrations by the teacher. Many schools are just beginning laboratory activities, and in these, by and large, it appears that the out-moded, traditional "cook book" method of following instructions from a laboratory manual is being followed. There are very few teachers who use both demonstrations and laboratory work in their teaching. The utilization of audio-visual aids is very limited, due probably, to the lack of professional training of the majority of chemistry teachers.

The secondary schools prepare their students for universities by giving their students as much as possible of the material taught in universities, thus leading to much useless repetition.

It is not generally realize that it is the quality of the teaching that needs to be changed and not the quantity.

The thesis recommends changes in the following areas related to chemistry teaching. The aims, the curriculum, the methods of teaching, the use of demonstrations and laboratory activities, the utilization of audio-visual aids, the relation of chemistry to daily-life, the evaluation systems and the preparation of the chemistry teacher.

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CHAPTER ONE

THE DEVELOPMENT AND PHILOSOPHIES OF THE TWO MAIN TYPES OF SECONDARY EDUCATION IN LEBANON

In order to understand clearly how chemistry is taught in the secondary schools of Lebanon, it is essential first to have a general idea about (a) the development of education in Lebanon, (b) the different systems of schools, and (c) the philosophy of education underlying each system.

A. THE DEVELOPMENT OF EDUCATION IN LEBANON

Education in Lebanon has developed and flourished largely through private efforts. Rivalry among the different educational organizations in the country has served as an important catalyst to promote educational development. It was not until the year 1951 that the first public secondary school was established in Lebanon. Continuous contact with the West through missionaries, mandatory rule, emigration, commerce etc., coupled with the deep desire of the people of the country to learn, made the land of Lebanon a fertile soil for Western educational theories and practices. It was the French missionaries who had sown the seeds earlier, and the French Government which had assumed responsibility during the mandate (1918-1943). It is to be expected, therefore, that in the larger picture of Lebanon a tinge of the French color of education will be detected. Why this has

remained, so, after 1943 is, in the writer's opinion, because most of those who took over control of education were, and still are, saturated with French ideas, theories, and practices. In addition, the Catholic Church, whose schools are responsible for the education of a large section of the population adopts French methods and ideals. Thus did the powerful voice of tradition drawn out the opposition; namely, the Anglo-Saxons, who also wanted to influence the educational system. However, in the last few years there has been a certain consistency in the clamor for reforms in the programs, methods, and policies of education. The demand, on the whole, has been for a system of education neither French nor Anglo-Saxon, but one that serves the interests and needs of Lebanon. "During the year 1954-55 a committee representing various philosophies of education was formed by the Ministry of Education to study the situation. After many heated discussions their suggestions were handed over to the Ministry in December, 1955. The suggestions of the committee were concerned with the curriculum and the examinations, and the Ministry promised to revise the program of elementary and secondary education in conformity with these suggestions at the beginning of the academic year 1957-58."(1) The symptoms of

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(1) Interview with Prof. Jibrail Katul, Professor of Education at the American University of Beirut.

reform began to appear upon the opening of five new public secondary schools on October 8th, 1956.

In October 1946, there emerged the present program of education for newly independent Lebanon. Presumably, it was a brand-new program prescribed by the Government through the Ministry of National Education. However, an examination of the programs of the French private schools prior to 1946, shows that they had been following substantially this same program except for the use of the Arabic language as the medium of instruction for geography, history, and civics. It is clear, then, that the previously existing schools, programs, and methods were the guide and pattern for those who brought forth a traditional French program, disguised under a new, national Lebanese name. The program of higher elementary education, as well as that of secondary education, refers to the teaching of the sciences in Arabic, French, or English. However, the Government has not taken the initiative of starting to teach these subjects in Arabic. And not a single school has been encouraged to do so. It is doubtful if in the whole Lebanon there exists, at present, a secondary school teaching these subjects in Arabic. One truly, new, and practical, provision in the "new" program is the acceptance of the English language as equal to the French, and the establishment of an English section (not requiring French) for the Lebanese Baccalaureat .

B. THE DIFFERENT KINDS OF SCHOOLS

Although education in Lebanon is represented in schools of different nations such as French, American, British, Italian etc., with their inherent differences, the diversities will overlap when classification is based on the prevailing philosophies of education. The result shows itself in two main types of schools, the French and the Anglo-Saxon. Each of these types runs institutions covering all stages of education The secondary school has been selected for special study in this thesis.

The French type comprises mainly the government schools, referred to hereafter as "public" schools, and the French schools which belong either to French missionaries or are Lebanese national schools following the French system. As was mentioned before, the curricula and methods of French and "public" schools are similar. Therefore, both may be conveniently included in the following discussion of the Public Secondary School System.

The elementary cycle of five years which ends with the examination of primary studies, the "Certificat", is followed by seven years of secondary education ending with the Part II Baccalaureat examination. Secondary education is divided into two cycles, the higher elementary cycle of four years,

ending with the examination of the higher elementary studies, the "Brevet"; and an upper cycle of three years. The first two years of this upper cycle lead to the Baccalaureate Part I examination. This is of three types: literary, scientific, and old languages. The Part II Baccalaureate examination is of two types: philosophy and mathematics. These examinations have written and oral parts. The French type of school is at an advantage over the Anglo-Saxon type because its students can sit for the French Baccalaureate which is officially recognized by the Lebanese Government as equivalent to the Lebanese Baccalaureate.

It should be mentioned here, that public higher elementary schools are intended to provide for those students who will terminate their formal academic education with the "Brevet". The purpose of this stage is to prepare students either to be admitted to vocational schools, (agricultural, industrial, commercial, and teachers' institutes) or to go directly into occupations. There is no basis for the division of students between full secondary schools and higher elementary schools except the availability of the schools. The programs of the higher elementary cycle and the first four years of the secondary cycle are, in practice, though not in theory, similar. This is fortunate for those who can shift to the full secondary school after the "Brevet", because their teaching is academic;

and unfortunate for those who cannot continue into higher education for the same reason.

The Anglo-Saxon type of school comprises the American and British missionary schools, as well as the national private schools, teaching in the English language. The heterogeneity of these schools is noteworthy. But, despite this heterogeneity, the philosophies of education and the aims of these schools are markedly similar.

There are differences in text books, curricula, distribution of courses, methods etc. It is difficult in this type of school to define the number of years of secondary schooling because of the differences and because they were, and still are, undergoing a period of transition in which they are trying to adapt the number of years of the different cycles of education to fit the government requirements. A few years ago, most of these schools had four years of secondary education after seven years of elementary. Lately, the tendency has been to reduce the years of the elementary cycle and to increase the years of the secondary one.

All secondary schools in Lebanon were asked to present their students to sit for the Baccalaureat Part I examination beginning in June 1955 and for the Baccalaureat Part II beginning in June 1956. Students graduating from secondary schools in and after June, 1956, will not be allowed, later on,

to practice any profession such as medicine, law, engineering, and dentistry unless they are holders of the Baccalaureat Part II.*

In the French type of school as has been mentioned, formal secondary education ends with Baccalaureat Part II. On the other hand, in the Anglo-Saxon secondary schools, students are expected to sit for Baccalaureat Part I at the end of their secondary education. Moreover, according to decree No. 7567, issued by the Ministry of Education on February 8, 1952, the Baccalaureat Part II is equivalent to the end of the sophomore year at the American University of Beirut. Whether this is a true equivalence is not the concern of this paper, but the stated equivalence has an important bearing upon the discussion in later chapters.

Quite a large number of schools in Lebanon run on a profit basis, and these schools attempt, by numerous means, to secure the maximum possible enrollment. One of these practices is to have two sections in the school, one following the French and the other the Anglo-Saxon system. Because of the inefficiency involved in diverting efforts into two conflicting systems, the standards of such schools are often low. Another way of attracting, and keeping, a maximum number of students is the introduction of specialties such as commerce and agriculture. Also, some of these schools adopt a coedu-

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*See Appendix E.

cational system, not so much because they believe it pedagogically sound, but because they believe that one teacher may thus be able to teach a larger number of students. This is demonstrated by the fact that in most such schools the girls occupy one side of the room while the boys occupy the other, and at recess time the girls and boys go outdoors to separate playgrounds.

C. THE PHILOSOPHY OF EDUCATION UNDERLYING EACH SYSTEM

The following is a translation from the Arabic of the aim of secondary education as given in the Lebanese program of 1946: "The aim of secondary education is to train and select the gifted youth of the country for the right orientation of the mind, for carrying the major responsibilities of public life, and for enlightened specialization in the branches of higher education."(2) The selective feature of the program is rooted in the fact that a pupil must pass the "certificat" examination to be admitted to a public secondary school. Intellectual training, that is, ability to think clearly and logically, are emphasized on the assumption tha t a well-trained mind will enable its possessor to solve all kinds of problems in other situations.

In part I of this chapter there was an implied criticism of the Lebanese program because it was adopted from the French. There are a number of reasons why the writer feels that this w wholesale adoption of the French system is not in the best interests of Lebanon. The earlier French system, as it has often been adopted and misapplied in Lebanon, symbolizes the bookishness and the memorization-without-understanding type of learning. It places the emphasis on the humanities and classics.

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(2) Lebanon, Ministry of National Education - Program of Studies. A translation from the Arabic original by Point IV Department of Education.

In short, it has not grown in response to the needs of the country. What makes the picture more gloomy is the fact that the French, themselves, have realized in the last few decades that they have not been following the right path in this scientific age. They have revised their own educational system, placing more emphasis on the child and the learning process, rather than upon subject-matter as such. But we, in Lebanon, have clung to an outmoded system, heedless of the fact that, even in its own birthplace, the originators of that system have considerably modified it to meet changing conditions.

The Anglo-Saxon schools tend to be progressive. Methods of instruction in these schools vary from conservative to progressive. Many of these schools, also, depend on rote-learning. Those that tend to be progressive are obliged to compromise their policies in order to prepare students for government examinations. As long as these examinations are compulsory, and as long as the examination questions depend more on memorization than on understanding, little change may be expected.

Because of these examinations and of the attempt of most schools to meet other requirements, such as those for entrance to the American University of Beirut, for the French Bacaalaureat and for the General Certificate of Education

examinations, the curricula tend to be overloaded. It is evident that the government examination is a source of trouble. But one of its purposes, which is the control of the schools, justifies it. Until there is a reasonable guarantee that schools will not exploit students for sheer profit, a certain degree of government control seems to be necessary.

One necessary reform is in the improvement of the means of control; i.e., in the improvement of examinations. Theoretically, private schools are subject to supervision by the Ministry of Education in other matters also, as stated in Article 13 of Decree No. 7000 of October 1, 1946. But, so far, this legislation has not been enforced.

The main problem of the secondary schools of Lebanon is that they prepare more than 95 per cent of their students for higher education while, in fact, only a small percentage of these students actually seek higher education. All terminal graduates of secondary schools look for white-collar jobs, and they despise manual work. As a result of the adoption (without adaptation) of these French educational ideals, and of philosophies in which the needs of the country are not considered, education is separated from life.

The report of the Lebanese Ministry of Education supports this statement when it mentions that "Graduates of

secondary schools presumably leave the school provided with intellectual and spiritual abilities, hopes, and desires; but as soon as they contact society they are bitterly disappointed when they find out the great difference between imagination and reality."[3] This is a clear recognition from those officially responsible for education in Lebanon of the fact that the existing school systems do not prepare students to enter their society as satisfied and productive members. Since the existence of the problem has been recognized, it is time for educators all over the country to join hands in the task of reorganizing the whole educational system in Lebanon so as to bring forth a curriculum through which the interests of Lebanon and the Lebanese may best be served. The efforts should not be restricted to the provision of a curriculum, but should be directed also towards providing the conditions necessary for its fulfillment.

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(3) This is the writer's translation from the report (in Arabic) of the Lebanese Ministry of Education submitted to the Conference on "Secondary Education in Arab countries", organized by the Department of Education at the A.U.B., in August 1956, page 11.

C H A P T E R T W O

AN EVALUATION OF THE STATUS QUO OF SECONDARY SCHOOL CHEMISTRY TEACHING IN LEBANON WITH SUGGESTIONS FOR IMPROVEMENT

INTRODUCTION

Many persons who have studied chemistry in the secondary schools of Lebanon were asked whether or not they liked chemistry; whether the chemistry they studied in the secondary school was ultimately useful to them; and if so, in what ways it was useful. There was general agreement that chemistry was not interesting, that it was a dull and dry subject, needing much memorization. In an attempt to find out the reasons behind this negative evaluation the writer distributed questionnaires to teachers and students (mostly recent graduates of secondary schools in Lebanon) pertaining to their chemistry experiences. Included in the questionnaires are such items as laboratory activities; demonstrations and audio-visual aids; the importance of chemistry in the curriculum; the number of years over which the secondary school course in chemistry is given; the facilities of schools for teaching it; the interests and reactions of students; and the qualifications and interests of teachers.

During the past year, many teachers and students were informally interviewed for the purpose of this study. Quite a number of schools were visited with the purpose of clearing up

points in the questionnaire that were not adequately answered, and for creating a clearer picture in the mind of the writer about the general atmosphere in which the teaching of chemistry is taking place. These contacts with students and teachers both in interviews and through the questionnaires were supplemented by the writer's own teaching experience.(1)

The status quo in the teaching of chemistry in the secondary schools of Lebanon, its evaluation, and suggestions for its improvement will be discussed in this chapter. The topics will be presented in the following order:

I. The aims and objectives of chemistry teaching

II. Syllabi in chemistry

III. Text-books

IV. The teaching of chemical theory

V. Demonstrations and laboratory experiences

VI. The utilization of audio-visual aids and other activities.

VII. Evaluation and examinations

VIII. Suggestions relating chemistry teaching to daily-life.

IX. The chemistry teacher

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(1) The writer has taught chemistry, physics, and mathematics for one year in the National College of Choueifat and for three years at the American Community School. In addition, he has worked in the Chemistry Department of the A.U.B. for two summers, and part-time during one academic year.

I. The Aims and Objectives of Chemistry Teaching

In order to see existing and proposed chemistry syllabi and teaching methods in their proper perspective, it is necessary to begin with a consideration of the goals to be achieved from the teaching of chemistry. There are explicit or implicit aims for any curriculum and for each course and activity constituting it. These aims are the only justification for teaching and they exist even though they may not be set down in school catalogs or in the government program of studies.

Why is chemistry included in Lebanon's syllabus? Chemistry is a part of the curriculum which was imported wholesale from the West. Government, as well as general, examinations include chemistry. Universities require science for entrance. For these reasons chemistry has found its way into the secondary school curriculum of Lebanon.

There is no doubt that the present aim of secondary school chemistry in Lebanon is the preparation of students for examinations and for college entrance. It is true that only a small percentage of students in Lebanon's secondary schools go to universities and, of these, a smaller number take chemistry courses in the higher level, and very few, indeed, ultimately specialize in chemistry. Therefore, the principal aims, objectives, and efforts of our secondary school chemistry teaching

should not be directed towards the purpose of preparing students for universities, to which most of them will not go. Even were it valid, the aforementioned existing aim is not being achieved judging from the grades of students of Lebanese schools in the Freshman class of the American University of Beirut.(2) Only the most qualified of secondary school graduates are recommended to, and enter, the university. The high percentage of failures on the Baccalaureat examinations, as well leaves much to be desired.(3)

A secondary school course in chemistry should take the following major objectives(4) into consideration:

A. Helping students better to understand and appreciate the role of chemistry in their lives, and

B. Helping students to reason more scientifically.

These are broad aims and they must be analyzed specifically in order to serve the purpose of the study.

A. Helping Students Better to Understand and Appreciate the Role of Chemistry in Their Lives

In order to understand and appreciate the role of chemistry in their lives, students must

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(2) According to information from the Registrar's Office of the A.U.B.:
The percentage of failure of all Freshman students in chemistry for the years 1952-56 is 29.04%.
The percentage of failure in chemistry of Freshman students who graduated from secondary schools in Lebanon for the years 1952-56 is 29.45%

(3) See appendix B

(4) These major objectives were taken from the Preface of the textbook, "Chemistry in Action," by G. Rawlins and A. Struble,p.v.

1) be equipped with some information about chemical facts, principles and theories
2) understand some of the applications of chemistry in their own lives, and
3) recognize the importance of chemistry in the modern world.

1) Information about chemical facts, principles, and theories

Chemical facts are needed not only for many professions, but also for citizens who want to lead happy, useful, and intelligent lives. There are minima of chemical understanding which any one who considers himself educated should possess. Current papers, magazines, and news broadcasts give an important place to scientific items. The pupils, after leaving school, should be able to keep up with advances in science which are affecting our lives tremendously, not to mention the significance of these advances to modern social and industrial life. It is necessary, therefore, that the students be familiarized with simple words and definitions in chemistry; elementary facts, principles, and theories in the subject; and the relationship between chemistry and other fields of knowledge. Also, it should be made clear to the student that chemistry is not a specialized, independent subject, but an integral branch of the whole structure of science. Scientific thinking cannot be developed without the study and

analysis of facts, and the application of chemical phenomena and laboratory work.

"In learning how to live we must consider the activities that make up life."(5) Facts, as considered here, are not ends in themselves. They are means to an insight into scientific methods and to an understanding of the solutions of scientific problems. The following are some of the advantages that may be expected from information about chemical facts, principles, and theories:

a) An understanding of the fundamental laws, and a mastery of useful principles governing the behavior of matter.

b) A better understanding of our environment in as far as chemical phenomena are concerned.

c) Provision of the background necessary to enable the student to recognize superstition and to correct erroneous interpretation, to acquire a chemical vocabulary, and to develop the ability to read simple chemical literature.

d) Provision of knowledge necessary to prepare the student for future courses in chemistry.

2) Applications of chemistry in daily-life situations

In the past, the emphasis in schools has been for the propa-

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(5) Smith and Hall, The Teaching of Chemistry and Physics in The Secondary School, p. 13.

gation of culture through the classics. But, in this practical age of science, "the pendulum has swung far over in the direction of subjects which may be characterized as having immediate bread-and-butter value."(6)

Applying simple chemical knowledge and relating it to daily life situations has been criticized on the ground that there are not many situations where chemistry is related directly to the life of the average person. This may be partially true. But an attempt should be made to pick out those items that are applicable, to assemble them, and to make use of them in teaching, so that chemistry will be more meaningful to students.

Most goods in the markets are manufactured by chemical methods. Labels on bottles and cans usually mention constituents, as well as their percentages, and directions for use. Many people cannot interpret simple directions of this sort even though they may have studied secondary school chemistry. Correct procedure in following directions is essential for the effective and safe use of many products.

Advertising is spreading widely in the present competitive markets. It is thus necessary to supply our students with tools to enable them to detect misleading advertising. If, for instance,

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(6) B.S. Hopkins, "The Cultural Value of Chemistry in General Education", Journal of Chemical Education, 11:410, Sept. 1935

two washing powders are advertised on the cinema screen, the consumer should be able to make an intelligent choice.

In explaining the poisonous property of carbon monoxide in a recent class, the students were reminded of "SABRINA", a movie that most of them had seen. They were asked why the actress ran the engines in a closed garage. The discussion that followed was developed to the conclusion that small concentrations of carbon monoxide when taken into the body are fatally poisonous. And it led to other questions, such as: "How is carbon monoxide taken care of in tunnels?" And: "What are the reasons for spraying household fuel gas with hydrocarbon oils?" Also, accidents of asphyxiation that occur in this part of the world each winter were considered.

Chemical research in vitamins enables people to make a more intelligent selection of foods. Results of research are summarised and tabulated in many chemistry books, journals, and periodicals. The average person should be equipped to make use of these in selecting a diet rich in vitamins, and furnishing an adequate number of calories.

This all adds up to the fact that students should be helped to learn to recognize applications of chemical principles and phenomena and that they should be taught in such a way that

their learning will be "functional".[7]

3) The recognition of the importance of chemistry in the modern world

It is necessary to know some chemistry in order to understand, even partially, the important changes that have been brought about in modern life through science, which affect every individual and society. Wars, and the fear of them, have emphasized the importance of chemistry to individuals, communities, and nations.

Science has served to make the world smaller. Nations are dependent upon each other more than at any time before. The facts and principles of chemistry are shared by all. New facts are published for international use, and individuals of many nationalities combine efforts to attempt to achieve progress. Problems of each separate country are becoming of world-wide concern. (For example, the rapid increase in the population of India creates the crucial problem of sufficient food supply - a problem which is surely of international concern.)

It is important for a genuine appreciation of science that the pupils should know that many of the conveniences that reach

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(7) The following, from the Thirty First Yearbook of the National Society for the Study of Education, page 42, clarifies what is meant by "functional":
"A functional understanding of a principle has been attained if the learner has acquired ability to associate with the principle the ideas from his immediate and from his subsequent experience that are directly related to it and if he is able to apply the principle in practical situations ....."

the average man today through chemists, and other scientists, were unknown even to the kings of the past.

It is difficult for the average person to realize that ordinary glass is made from sand, soda, and lime; or that the variety of beautiful and durable dyes, found in the home and in the streets, have their origin in coal tar; or that chemistry is important even in the insurance business where account must be taken of the likelihood of accidents, fires, boiler breakdowns and so on.

In conclusion, a broad understanding and a genuine appreciation of the chemical phenomena of the universe, of the place of chemistry among the sciences, and of what the development of chemistry means in modern social and industrial life should be given to the individual through the study of chemistry.

B. Helping Students To Reason More Scientifically

"Recognition of the need for the application of organised scientific method has spread to the degree that a wide variety of people look to it as a guide in their private and public affairs. The farmer no longer struggles alone; he resorts to agricultural research foundations in his country or outside it, looking for help in production and distribution. The industrialist, as well, does not depend upon imagination and risk as much as on numbers and facts. Similarly, although on a smaller

scale, the merchant, the worker, and whoever undertakes private enterprise seeks the methods of science. The same can be said about social and educational problems like the relationship between employer and employee, preventive medicine, social security, education and teaching."[8]

Chemistry is an experimental science. The development and application of its basic laws and theories need and promote logical thought, systematic reasoning, and clear thinking. These are some elements of the scientific method.

Educators seem agreed that a "scientific attitude" needs to be developed in the students. The "scientific attitude" is best observed in the use of the scientific method. This term, "scientific method", has been overused. The following is the writer's summary of the main steps in problem-solving by the "scientific method" as agreed upon by most writers:

1) A problem is perceived
2) Relevant information and data are collected and organized
3) A tentative hypothesis is formulated
4) Experiments are performed to test the truth of the hypothesis

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(8) The writer's interpretation and translation, Costi Zurayk, "Scientific Method and Our Need To It," Al-Oulum Journal (Arabic), 1:6, March, 1956.

5) A generalization is made from the hypothesis

6) The generalization is verified for additional specific cases by conducting more experiments.

Some of the specific and desirable outcomes of the development of the scientific method of thought are:

1) To give the pupil an insight into the field of science so that he may explore his interests, capacities, and abilities as a basis for the selection of further courses in science, for the selection of a vocation, and for acquiring new fields of interest.

2) To develop the power of experimental observation and interpretation; to encourage reliance on facts; to form independent judgment; to plan prior to execution; to gather data systematically; and to recognize defects and errors in conditions and processes.

3) To promote the scientific attitude i.e., open-mindedness and willingness to consider new facts. To develop intellectual honesty, caution, integrity, suspended judgment as well as critical judgment. To be always unwilling to generalize from insufficient data.

4) To encourage scientific behavior, such as the ability to view objectively and to show freedom from superstition, to accept the necessity of revising an opinion if new evidence so warrants, and to exhibit a spirit of inquiry.

Teachers should strive to impart the "scientific method"

so that it will become a part of self and a way of living. A knowledge of five or six steps to be followed in solving a problem is far from forming a scientific method. A scientist does not follow certain steps rigidly. If he does so, his method ceases to be scientific. The ability to gather, analyze, and classify data, and to draw valid conclusions (which are the elements of the scientific method) is most important for students to acquire.

As was mentioned by the Committee on "Science Education in American Schools" in the Forty Sixth Yearbook of the National Society for the Study of Education: "In science lies man's hope for his continuous and progressive welfare. It is for this reason, fundamentally, that science justifies, even demands, a prominent place in the school program".(9)

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(9) Page 24

II. Syllabi in Chemistry

The syllabus is of primary importance because it defines the boundaries within which the teaching of chemistry takes place. It is essential in the present study to bring forth the type of material which is being presented in Lebanese secondary school chemistry courses, the number of years over which it is presented, and who decides what shall be presented and how.

Article 13 of Decree No. 7000 of October 1, 1946 stated that "the program of private schools, whether native or foreign, is the program of the public schools". However, it is evident that this is not being put into effect. The government is trying to enforce it indirectly by requiring students to sit for the Baccalaureat. A study of the impact of this requirement on private schools, and their reactions as manifested by changes in their programs will reveal this quite clearly.

Until a few years ago, all students were required to follow the same program in any school following the Anglo-Saxon system. Lately, new sections have been introduced in some schools, mainly commercial sections. Division into sections is usually done in the last two years in some of the larger Anglo-Saxon schools. It was originated as a solution for the problem created by those who fail, or those whose grades indicate that they are not prepared for the academic type of learning. Otherwise, all students in the academic schools are required to follow an identical

program of studies, without electives. Schools following the French system are divided into literary and scientific sections at the beginning of the sixth year, i.e., the year at the end of which their students sit for the Baccalaureat Part I examination.

The present government curriculum was prescribed by central authority in a series of legislative decrees dated October 1, 1946. The program of studies in chemistry is so detailed that every topic and every element or compound to be studied is listed. The government program stresses isolated facts about certain elements and compounds, without emphasizing the important general principles and laws that are obeyed in many reactions. There is no mention of relations among properties of certain groups and families of elements. This makes the subject appear dry, difficult, and uninteresting.

According to this program, secondary school chemistry is offered over a period of seven years, starting directly after the "Certificat". It starts with one period per week for the first four secondary classes, and increases with the higher classes. How much chemistry will the student know after twenty-eight periods of chemistry distributed over an academic year? What is the use of discarding general science and starting specialization at such an early stage? Is this not another way to make chemistry unimportant and uninteresting, especially since the teachers of the lower grades of the secondary schools are, in

general, very poorly equipped to teach it?

Our understanding of nuclear energy has advanced considerably since 1946, and many discoveries have been made. Is there nothing of importance in these new discoveries that should be included in the seven years of secondary school chemistry, calling for a modification in the program? Many schools in England, in the United States, and even in France are basing their modern teaching of secondary school chemistry on the atomic theory. It is the duty of curriculum prescribers to consider these innovations in method, so that they may uncover new viewpoints that will make chemistry more comprehensible and more interesting. And last but not least, the government program makes no mention of individual laboratory instruction. Most educators agree that proper laboratory instruction not only arouses interest, but also facilitates the understanding of principles and laws.

Anglo-Saxon schools do not follow any single program. Each school bases its policy upon the wishes of the principal or the teacher of chemistry. But the principal rarely knows enough chemistry to be the person responsible for deciding how many years or how many hours per week, of chemistry are needed. Nor is the chemistry teacher always trained, and ready to exert the effort and to spend the time needed to elicit the best results. However, it should not be expected that principals or chemistry teachers will be experts in making programs, since they are often not trained for it. Therefore, they should seek help from those

who know and are ready to give it. They should investigate the literature of chemical education to discover what was workable under similar situations in other countries, and what may be applicable in Lebanon.

In order to meet the requirements of the Baccalaureat examinations and to prepare their students for the freshman chemistry course, which was introduced in its new form in October 1951, many schools have been tending to give more and more importance to chemistry by teaching more of it over a greater number of years. The results of the question for teachers asking "For how many years does a student study chemistry in your school?" are shown in Table I:

TABLE I

Number of Schools Teaching Chemistry over various periods of years

Number of Years during which Chemistry is Taught	Number of Schools
7	5
6	3
5	3
4	3
3	9
2	13
1	2
Total	38

The average number of years during which secondary school chemistry is being taught in these thirty-eight schools is 3.55. The average number of periods per week of regular classroom teaching of chemistry in these schools is 2.85.

Table II shows the number of hours of chemistry and other sciences per week according to the program of the public schools of October 1, 1946:

TABLE II

Hours Per Week For Various Sciences
According To The Government Program
Of October 1, 1946 For Secondary Education

Years of Study	Subjects	Hours/Week
First & 2nd years	Physics, chemistry & biology	4
Third & 4th years of Higher Primary schools	Physics, chemistry & biology	4
Third & 4th years	Physics, chemistry & biology	3
Fifth & 6th years	(Literary Section) Physics & chemistry	3
Fifth & 6th years	(Scientific Section) Physics & chemistry	6
Seventh year	(Philosophy) Physics, chemistry, & natural science	5
Seventh year	(Mathematics) Physics, chemistry & natural science	9

Thus far, this presentation has shown that the existing programs are rigid and overloaded. They are prescribed by the Government directly for public schools and indirectly for other schools through the examinations. The programs require a thoroughgoing analysis and reorganization.

In drawing up a syllabus for chemistry in the secondary schools, it should be kept in mind that most of the students have their first and final formal contact with chemistry in the secondary schools. Therefore, it is essential to determine what all students should get out of this course. As students beginning chemistry have different experiences, abilities, and interests it is not possible to prepare a syllabus that satisfies all groups. This is one reason why a syllabus should not be rigid but adaptable and modifiable. The majority of the students (forming what amounts to the central bulk of the normal curve) should be considered in drawing the main outlines of the syllabus. Those at the extremes should be taken care of through special adaptations and modifications. A varying amount of work in assignments, problems to solve, reports, projects, outside reading etc., can be made use of in adapting the syllabus to the needs of extreme cases. In preparing a program, the age level of the students and their aptitudes should be taken into consideration. The program should be flexible; it should provide the backbone without going into details, thus giving liberty to schools to apply it according to local needs and conditions.

The statements in the syllabus alone do not constitute a reliable guide to the kind of course which is offered. The methods through which it is offered, as well as the accompanying experiences have much bearing on the value of the course. Secondary schools should be evaluated more by what their students can accomplish and less by their physical facilities and the number of topics in their program of studies.

It is the belief of the writer that a chemistry course in the secondary schools need not be patterned to fit the requirements of colleges and examinations. A course meant for the general education of students, wherein they are helped to understand the principles underlying chemical phenomena, the applications and contributions of chemistry, and the value of scientific and logical reasoning, may serve better to achieve realistic aims for the teaching of chemistry at the secondary level, for both terminal and college-preparatory students.

What type of chemistry course can be useful, meaningful, and intellectually challenging? What type of course can be beneficial to both college-preparatory and terminal students? What type of course can be "functional", so that it will do more than load the students with isolated facts-- facts which will not stand the weathering of the three months of summer vacation? These questions must have arisen in the minds of many secondary school teachers and principals. At present, secondary schools in Lebanon, in general, are turning out prospective university

students who can remember facts and who can solve only stereotyped problems which depend on substitution into specialized formulas. The better secondary schools try to teach a duplicate of the college freshman course. Teachers come to the University to get syllabi of freshman chemistry and copies of the laboratory manual. The secondary school program includes and emphasizes primarily those topics which are stressed in universities and in examinations. Naturally, they want their college-preparatory students to pass the examinations and to do well in college. But by and large they ignore the needs of the majority of students whose formal education stops at the end of the secondary school. Principals and school owners are often concerned with prestige and self-interest. They feel that recognition will come from the success of those of their students who take general examinations and who attend universities. Success or failure in the lives of their terminal students is not likely to be noticed by the college-conscious community to which they belong.

The syllabus should be a compromise between the requirements of the college-preparatory and the terminal pupils. It should be flexible enough to meet local conditions, adequate for college requirements and comprehensive enough for the serious pupils who need a general view of the field of chemistry. The course, among other things, should provide the students with the common everyday facts, ideas, and nomenclature of the subject in order that they may be able to follow new developments and take

part in intelligent conversation regarding it.

The suggested organization of secondary chemistry course with its secondary science background is as follows:

Examination: "Certificat". The "Certificat" examination concludes the five years of elementary education. Students are then usually about eleven or twelve years old.

First secondary class		3 hours per week of general science
Second secondary class		3 hours per week of general science
Third secondary class		3 hours per week of general science
Fourth secondary class	Biology	4 hours per week plus 1 hour of laboratory
Fifth secondary class		
	Chemistry	3 hours/week plus 1 hour of laboratory/ 2 weeks
	Physics	3 hours/week plus 1 hour of laboratory/2 weeks
Sixth secondary class		
a) Literary	Advanced General Science or Chemistry or Physics	3 hours per week plus 1 hour of lab.
b) Scientific	Chemistry and Physics	3 hours/week plus 1 hour laboratory
c) Technical	The science course offered and the number of hours per week depend upon the technical branch followed.	
Examination	Baccalaureat Part I	

Comments on the Suggested Program

1) This program of studies is suggested for a secondary school of six years at the end of which a student is expected to sit for the Baccalaureat Part I examination.

2) By the end of the fifth year, students may be expected to know enough about biology, chemistry, or physics, to enable them to make a decision as to the branch of science to be followed later. Teachers will have had the opportunity to evaluate the scientific aptitudes of their students, and thus can be more helpful in guiding students into appropriate lines of study.

3) It is to be preferred that the advanced general science course be given to the literary section in the sixth year instead of courses in chemistry or physics. The latter are meant for students who will be required to take a science course in the freshman year at the American University of Beirut.

4) It is believed that it would be beneficial for Arts students in the freshman class of the American University of Beirut to be given an advanced general science course rather than a specialized science. An alternative would be for the Chemistry Department to give a special course in chemistry for Arts students - a course that is frankly intended to contribute to a liberal education rather than to prepare future science students.

5) One drawback, however, to the general science course would be the difficulty of finding teachers with sufficient training to teach general science at the higher levels of the secondary school and in the freshman class of the University. Perhaps it

would be appropriate for the Education Department of the American University of Beirut to start a teacher training program with this aim.

It should be noted that not a single school in Lebanon teaches secondary school chemistry in the mother tongue of the students, i.e., in Arabic. The writer has read a number of articles and discussions on this subject which usually end by asking the government to pass a law enforcing the teaching of the sciences in Arabic. In so far as the teaching of science is concerned, the government gives Arabic the same consideration as the English or the French languages according to the program of October 1, 1946. But in spite of this the sciences are not taught in Arabic. Educators believe in experience, and often ask the question "Did it work when tried?" It has not been tried in Lebanon to any significant extent, but according to experiences in neighboring Arab countries, teaching chemistry in Arabic is not as great a handicap as it is sometimes believed to be. A definite study is needed to find out which language does the best job of teaching. The reasons most often given against teaching chemistry in Arabic are those related to higher education and the need for reading foreign chemical literature and abstracts in advanced work. As long as secondary education in Lebanon is meant for the gifted youth, the problem remains controversial, because most of the gifted youth will proceed to the universities. But, if it is agreed that secondary school education is actually for the average

teen-ager, who probably is not going on to a university, it is only natural to expect that he will understand chemistry much better when it is explained in his mother-tongue than when it is given in a foreign tongue. The students who will eventually go to universities will not necessarily lose by this procedure. Many students who have studied chemistry in Arabic in the government schools of Palestine, Jordan, Syria, and other Arab countries, have done very well in this course in universities. Many of them study the sciences in Arabic, learning some of the related English conventions and terms as they go along, and end by passing the London General Certificate of Education Examination in the subject. Some students pass freshman chemistry at the American University of Beirut without having had any chemistry at all.

It seems, from many writings and discussions on the subject, that there is little initiative. If the administration of a school feels that it is better to teach the sciences in Arabic, the next step, and the most convincing proof, is to teach it in Arabic and thus to prove its workability without the necessity of passing laws forcing all schools to do the same.

III. Text-books

Generally teachers in the secondary schools of Lebanon depend heavily on books, and in most cases the book at hand determines the content of the chemistry course. Since books play a very important role in the teaching of chemistry in the secondary schools of Lebanon, it is appropriate to examine carefully the kinds of text-books in use, their content, the sequence of topics in them, and the criteria used in selecting them.

An examination of current text-books in the secondary schools following the French system reveals a sequence of topics in the text-book somewhat parallel to the sequence of topics in the government program of studies. A general feature of these books is the inclusion of many topics in highly condensed form.

Special attention was given to a French chemistry text-book[10] for the second, third, and fourth years of secondary school chemistry. It was published and printed in Paris in 1955. In ten pages (pp. 108-118) this text-book deals with modecules, atoms, affinity of molecules (cohesion), Avogadro's Law, atomic weights and molecular weights. Later topics in the book are not based on the atomic theory that is discussed in these ten pages.

The schools following the Anglo-Saxon system use either British or American text-books. According to the answers to

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(10) Cours de Chimie, par Une Reunion De professeurs, Ligel, 77, Rue de Vaugirard, Paris-VIe

question No. 7 in the questionnaire for students (recent graduates of Anglo-Saxon schools), it appears that there are three or four text-books used by most schools.

Table III shows the number of Anglo-Saxon schools using various texts:

TABLE III

Numbers of Anglo-Saxon Schools Using Various Chemistry Text-books

Book Title	Number of Schools
School Chemistry For Today by Goddard & Hutton	9
New Practical Chemistry by Black & Conant	4
Chemistry at Work by McPherson	3
Introduction to Chemistry by Brown	2
Inorganic Chemistry by Smith	2
Visualized Chemistry by Lemkin	2
Fundamental Chemistry by Wilkins	1
General Chemistry by Holmes	1
	Total 24

Some schools prefer British books because they are much cheaper than American books. Most of the text-books in use by Anglo-Saxon schools emphasize general inorganic chemistry at the expense of organic chemistry. The trend in current secondary school chemistry books written in the English language is towards placing a greater emphasis on such topics as atomic theory,

valence, ionization, molecular structure, radioactivity, and the periodic table. Recent books tend to deal with units of chemistry, thus combining interrelated topics in chapters grouped under one title for the unit. Text-books are keeping pace with progress in chemistry by adding more and more topics, and this results in a larger number of pages and thicker books.

Most text-books in use today have a summary or a group of questions for review at the end of each chapter and/or at the end of each unit. These help students a great deal in recapitulating different topics and in integrating them into a broader view. In some cases, basic principles are illustrated through problems and questions only in the chapter where these principles are presented, and are not repeated or referred to in subsequent chapters.

There is no fixed policy in the use of text-books. Any book which is not banned by the Ministry of Education may be used. In Anglo-Saxon schools the choice of the text-book is sometimes left to the teacher and sometimes to the principal. There is much less freedom in the choice of books for both teachers and principals in schools of the French system, especially if the school is one of the number which follow an identical organization. Very often the choice of books is not based on a careful study of the text, but on the fact that other schools are using it.

The Anglo-Saxon schools have been in confusion for the last few years because they have not been able to find text-books written in English that follow the sequence of the government program, or that contain all the topics involved. Most of their teachers have resorted to dictating notes or distributing mimeographed notes to students to supplement or replace the text-book.

There has been no chemistry text-book written exclusively for students in Lebanon. All the text-books in present use were originally meant for French, British, or American students. The examples given in these books are taken from the environment of the students in these countries, and not from the environment of the students in Lebanon. This is one reason why teachers should not be slaves to the text-books but should supplement them as far as possible from their own experience, and from other books and periodicals.

It would be both more beneficial and more attractive to students in the secondary schools of Lebanon to study a chemistry text written expressly for the use of students in Lebanon and neighboring Arab countries. It is much more convincing for a Lebanese student to read about stalactites and stalagmites in Kadisha or Afqa rather than in Dovedale, and to be referred to the Dead Sea instead of the Great Salt Lake.

Most text-books, especially those written in French, tend

to present isolated concepts and facts, which are apt to be forgotten easily. For effective learning, such concepts and facts should be related to one another and should be used to interpret certain principles in the subject-matter. Most books follow certain monotonous, rigid patterns in studying the elements. For example, the lesson may start with the discussion of the history and the discovery of the element, followed by its occurence, physical properties, laboratory preparation, commercial preparation, chemical properties, and uses. Even though these fully treated topics may not leave out any elementary information about the element, the purpose of chemistry teaching should not be to have students memorize all these facts about the elements.

Many teachers may agree regarding the topics to be covered in a general chemistry course; but, as to the details of the topics and to their sequence, opinions vary greatly. The place of atomic structure and the periodic law seems to be a special problem for text-book authors, if judgment may be made from the different placements of these topics in different text-books. It is the writer's belief that they should be introduced early in the course so that they may help in the discussion of subsequent chapters. It is the custom in many current text-books to do the opposite, i.e., to give statements and refer the students to subsequent chapters for explanation. However,

there is a trend towards starting with the structure of matter and building later discussions as much as possible upon it. Chemistry has changed; the atomic theory was not included in the text-books of two decades ago to any considerable extent. It is necessary, at present, to set up a sequence of topics that pays the maximum dividends and that makes it easier for students to understand and for teachers to teach efficiently.

Whenever necessary, teachers should help students to understand that the text-book is fallible; that they should not blindly accept the book as an authority, but should consider it critically. Some errors are serious factual ones, others are typographical slips. It is one of the aims of teaching chemistry to help students to think exactly. A statement is inaccurate not only when it is false, but also when it is partly true or when it applies only under certain conditions. For example, one book defines "molecule" in the glossary of terms as "the smallest amount of a compound which can exist by itself." One student gave this quotation as the definition of a molecule. The student was then asked to give an example, and he quickly said, "O_2". "Is O_2 a compound?" was the next question. The student was perplexed because he could not fit the example to the definition, and he said, "something is wrong". Something <u>was</u> wrong and he was required to think it out. Too often he is merely required to sit down.

The idea that the book is infallible should never be allowed to enter the minds of the students. The writer recalls giving to a class of thirty-five students a five-minute open-book quiz on a problem for which the solution had been given in the text-book assignment for that day. Only nine students, some of whom had not looked at the lesson, got it right. The remaining twenty-six reproduced it exactly as it appeared in the book and got it wrong, because the solution of the problem was incorrect in the text-book. Subsequently most of the students showed a healthy suspicion of "solved" examples in the book, and began to check them and to try to understand them.

The science of chemistry has been growing so rapidly that continual modification of text-books has been necessary in order to add newly discovered facts. As the text-book determines the kind of course given, especially when it is in the hands of inexperienced teachers, special attention should be given to the choice of a text-book. A careful, continuing study of new books should be made by teachers of chemistry, groups of teachers, and special committees for the purpose. New text-books are continuously being issued, and the same text-book should not be used for several years, as is the case in many schools. Since students usually buy their own books, there is no financial reason why new books should not be introduced whenever a really better text-book becomes available. It is totally irrelevant

to argue that it is easier for the teacher to use the same text-book over and over again. Chemistry is a changing and rapidly developing science, and teaching it efficiently is quite difficult. Therefore teachers should always be on the lookout for text-books that will contribute to better understanding. The size of the book; the content; the number of years over which it will be taught; the sequence of topics; the figures, diagrams and graphs; the interrelatedness of topics; the kinds of questions and problems provided at the end of each chapter or each unit; and the extent to which the text-book appeals to the students-- all these factors should be taken into consideration in the choice of a text-book.

Text-books should help motivate students to think. They should help to develop creativity and initiative. Secondary school chemistry text-book authors should switch from emphasis on factual information to emphasis on the underlying principles of the science. For example, in the laboratory preparation of carbon dioxide, instead of saying that hydrochloric acid is added to calcium carbonate, it is much more helpful to say that an acid is added to a carbonate. This should be followed by a number of examples illustrating the statement, and by remarks covering any exceptions.

The teacher should not be slave to the text-book. He should use it as a means and an aid to help students to learn and to

understand. Text-book materials should be supplemented by reference to other books, scientific journals, advertisements and periodicals.

IV. The Teaching of Chemical Theory

A salient feature of present-day chemistry teaching in the secondary schools of Lebanon is the emphasis on subject-matter. Memorization and recitation of laws, theories, and facts in themselves are far from being a guarantee that students will be able to use them for practical purposes. This fact is being overlooked. Facts are being taught as though they were ends in themselves, and not means to ends. Very little effort, if any, is being exerted by chemistry teachers to relate the topics to general principles or to emphasize applications.

Quite a large proportion of students and graduates of secondary schools of Lebanon do not like chemistry. In answer to question 14, in the questionnaire for students, "Did you like chemistry as it was taught in the secondary school? Why?", out of the 122 who answered, 68 students said that they did not like it, while 54 said that they did. The most frequent reasons for the dislike of chemistry were, in order of their importance as indicated by frequency of response:

1. Memorization emphasized at the expense of understanding.
2. Uninteresting presentation by the teacher.
3. No experimentation.
4. Teachers not good.
5. Course vague and difficult.
6. Memorization of unnecessary things required.

7. Teachers lacking interest in the teaching of chemistry.

8. Course dictated.

It should be noted that the objection to memorization was proportionally more frequent among students in schools following the French system.

Reasons given by students for their liking of chemistry were, in order of their importance as indicated by frequency of response:

1. Interesting.

2. Well-taught.

3. Experienced teacher with interesting method.

4. Very elementary, simple, and easy course.

5. Kind and fair teacher.

6. Many discussions in class.

7. Useful course.

8. Interesting laboratory work.

9. Variety in the teaching method.

Most of the suggestions which students were asked to give at the end of the questionnaire, center around the introduction of experimental work and the elimination of rote memorization. The suggestions, beginning with the most frequent, were as follows:

1. More well-equipped laboratories to be used by students in individual laboratory work and for demonstrations.

2. Stress on understanding as opposed to rote memorization.
3. Better teachers.
4. Well trained teachers who understand students and know how to interest them.
5. Variety in method of presentation.
6. The use of audio-visual aids.
7. Less emphasis on minute facts that are easily forgotten.
8. A better text-book.
9. Teachers of chemistry who are specialized in chemistry.
10. Less dictation of notes.
11. More importance to be given to chemistry in public examinations so that it will not be neglected by school officials and by students preparing for such examinations.
12. Assigning definite periods for laboratory work instead of leaving it to the judgment of the teacher.

These suggestions from students who, in most cases, have just graduated from secondary schools, seem to be a useful part of the questionnaire because they have served as an outlet for suppressed complaints, and they are thus very likely to reflect an accurate picture of the teaching of chemistry in the secondary schools of Lebanon.

It is not easy to understand chemical hypotheses, theories, and laws in the absence of efficient teachers. As a result,

students resort to rote memorization of the laws and definitions in the text.

In discussing the teaching of chemical theory it may be helpful to go over the answers to the related questions in the questionnaire of students. In answer to question number 21, "Did your teacher lecture much in class?" Out of 123 answers, 90 students answered positively, while 33 students answered negatively. This shows that a significant proportion of chemistry students felt that they were spending much time under conditions where students assume a passive role. The students' notebooks are often a disorderly and disconnected group of sentences that have no meaning. Sometimes they contain a few words from each sentence that the teacher says. It is pedagogically unsound, and uninteresting for students, to attend a course in beginners' chemistry in which the teacher lectures or reads his notes most of the time.

In answer to the question, "Did your teacher conduct the class most of the time by questions and answers?" Out of 124 answers, 63 students said yes; 58 said no; and three said sometimes. Teachers are often observed sitting at the desk or standing by it, with the book open before them, asking questions from it, and sometimes verifying the answers by referring to the book. The confidence of pupils cannot be won in this way. At certain times the use of the book is justified, but, in general,

it is desirable to make minimum use of the text-book in the classroom.

To combat verbalism and memorization the present types of questions and problems used in quizzes, tests, and discussions should be changed to reflect understanding rather than memorization. This will be discussed in more detail later, under "Evaluation and Examinations". Suffice it to say that the types of questions asked in the everyday running of the classroom should be revised. The questions should be thought-provoking. Some examples of good procedures follow:

1. The teacher asks whether sodium is a liquid or a gas at room temperature instead of asking whether it is a solid or a liquid. This eliminates guessing, since sodium is a solid at room temperature.
2. The teacher asks students to give illustrations of the law or principle under consideration, from common knowledge and experience.
3. The teacher requires students to give definitions and explanations in their own words, and does not accept the words of the text-book without finding that a student can also express them correctly in other words.
4. The teacher encourages students to ask questions. Their questions should be taken seriously by the teacher as long as they are asked seriously. The teacher should

do his best to be ready to give satisfactory answers to the stream of questions that inevitably arises in the mind of the thinking student. The wise teacher does not expect perfect statements at the beginning of the course but trains students to weigh their words. Students should be encouraged to think. To make fun of their mistakes will discourage them from thinking for themselves.

5. The teacher tries to be slow at the beginning of a course so that the student will feel from the first that he is getting something out of it. If the teacher is so quick that the student is unable to keep up, he will be discouraged.

The distribution of the responses for question number 23, "Relatively, how much time was spent by your teacher in dictating notes?" is shown in Table IV:

TABLE IV

Responses to the question, "Relatively, how much time was spent by your teacher in dictating notes?"

	Number of students	Percentage
Very much	32	25.4%
Much	29	23.0%
Some	36	28.6%
Very little	29	23.0%
Total	126	100.0%

The above figures show that a considerable amount of time is spent by teachers in dictating notes to students. It is a very easy way of teaching. The notes are available in the teacher's notebook, and have been piling up for years. Changes or modifications of the notes will probably occur only when the teacher discovers changes in the types of questions in the official examinations.

Notes in class should not be taken verbatim (word by word) unless something brief is being dictated. Mimeographed sheets should replace lengthy dictations. Students should be trained to follow the reasoning of the explanation in class. Students should be trained to understand first, and then to take notes if necessary. Clear, brief statements arising out of understanding form a better record in the note-book than long, disconnected sentences punctuated by blanks intended to be filled in later.

According to the responses to question number 4, in the questionnaire for students of Anglo-Saxon schools, "How many students were in your last secondary class (one division)?", the average class size was 22.54 students. The question was different for students of French schools, and its English translation is: "On the average, how many students were there in every class of this school?" The answers are listed in Table V:

TABLE V

The Average Range of Number of Students in Every Class of Schools of the French System

Range of Number of Students	Number of Responses
Less than 20	7
Between 20 and 30	20
Between 30 and 40	13
Above 40	1
Total	41

Classes, in general, are not overcrowded, especially in the higher classes. In spite of this, teachers do not, and sometimes cannot, pay individual attention to students. If there is any help given, it is usually to the weak student. Not much is being done to promote the scientific interests of the exceptionally able, who are the reservoir of Lebanon's potential scientists.

Many teachers, specially in the lower grades of the secondary school, teach chemistry in spite of the fact that they have not had adequate preparation for it. They cannot instil in their students a "spirit" of science or an interest in it because, in many cases, they do not have these themselves.

These students are apt to have their minds pretty well set against chemistry because of poor teaching in the lower grades of the secondary school. It takes the ingenuity of the subsequent teacher, however rare, talented, and efficient he may be, to enliven the subject of chemistry after the earlier disillusionment.

The present methods of teaching chemistry in the secondary schools of Lebanon are often based on the following assumption, very well worded by Eckels: "Too many teachers assume that exposure to a body of subject-matter which has its foundation in clear thinking automatically induces that process which led to its being."(11) Facts and details which are memorized in any course of study are retained for but a short time after the completion of the course. Facts which are required for future work can be obtained when needed.

If there is any permanent value in a course, it is in the development and training of mental and manual abilities and in teaching students how to look for facts when they need them.

Creative imagination is missing in the secondary schools. By creative imagination is meant the habit of the mind to be always alert to the need for fitting each new fact into proper relationship with things already known. Chemistry students need

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(11) Eckels, Clear Thinking through Use of Subject-matter materials, Journal of Chemical Education,

to acquire the mental habit of fitting together the ideas, principles, theories, and facts that they learn. They should turn them over and play with them in their minds, so that new interrelations may be formed and new ideas may emerge.

The value of teaching shows itself in the use made of information rather than in its reproduction. To be able to utilize the material studied, students need to understand it thoroughly. Methods of teaching should be modified to insure as much as possible such an understanding. Any shift in classroom technique which moves away from the formal lecture or the dictation of notes is likely to be helpful. Although it is a more difficult technique to lead a class through active discussion, it can be much more interesting and far more rewarding.

The facts of chemistry are increasing so steadily that the teacher himself must refer to books quite often, and sometimes he cannot even reproduce what he expects his students to reproduce. It is very difficult to remember the properties and behaviors of the increasing number of chemical sustances found in secondary school chemistry text-books. Grouping these under principles which will point up similarities and differences will help to a large extent. There are certain minimum essentials such as chemical vocabulary, symbols, atomic structure, and kinetic theory that are fundamental and should form the foundation of any course. The student must acquire the new vocabulary

before he can understand chemical phenomena. Knowledge is cumulative, depending upon previous work. If a student fails to learn valences, he will certainly not be able to write formulas and equations.

Since principles help a great deal in learning secondary school chemistry, they should be stressed. "The problem of teaching, both by general principles and by specific examples, is a fundamental problem in science instruction. No rigid rule can be laid down. The skill of a teacher can nowhere be better shown than in the way he blends these two factors into his methods. The understanding of the applications and limitations of the general principle should be as clear as possible at the given level of the students. The teacher should not hesitate to point out limitations, and even to give examples. Thus a student even in the secondary school, learns to avoid dogmatic statements, even while he is seeking guidance from, or appealing to, a general principle or theory."(12)

Much has been said about general principles and generalizations. It seems appropriate to give a few illustrations at this point:

Failing to understand the principle of writing chemical equations, students often attempt to make up for the deficiency by memorizing as many of them as possible. Given the reactants,

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(12) Quoted by permission given in a note from Professor William West, of the Chemistry Department of the American University of Beirut.

in order to write a chemical equation the student has to know the products, the formulas of the substances involved, and how to balance the equation. Writing formulas of elements and compounds, with adequate drill on them, should come before writing chemical equations. This will eliminate much difficulty. Valence must be made use of in writing formulas. Remembering four or five common valences will help in writing correctly scores of formulas. One of the greatest problems to students is what the products of the reaction are. Here some general rules are of great help. These help to free the mind from many memorizations, and they require active thought when they are applied:

1) A metal above hydrogen in the activity list + an acid (not oxidizing) gives a salt and hydrogen.

   $Zn + HCl \text{ --- } ZnCl_2 + H_2$

   $Mg + H_2SO_4 \text{---} MgSO_4 + H_2$

2) An acid + a base gives salt and water.

3) A metallic oxide + an acid gives a salt and water.

4) A high boiling point acid + a salt of a more volatile acid gives the salt of the high boiling point acid + the more volatile acid.

This general principle can be applied to the conventional classroom preparations of HCl, HNO_3, CO_2, HBr, HI, H_2Setc. In the preparation of CO_2, SO_2 and H_2S, the weakness of the acid

is the first factor.

5) A strong base liberates a weak base from one of the salts of the weak base. For example, the evolution of ammonia from ammonium salts when a strong base such as sodium hydroxide, or potassium hydroxide, or calcium hydroxide is heated with it.

6) The complete combustion of a hydrocarbon yields carbon dioxide and water vapor.

7) Potassium, sodium and calcium react with water to give a base + hydrogen.

These are some of the general principles for writing equations. True, there are many equations that do not fall under definite general principles, but secondary school students should not be expected to be able to write every kind of equation.

Why should a student memorize the densities of gases at S.T.P. if it is possible for him to calculate the density of any gas at S.T.P. or at other conditions from a knowledge of the molecular weight of the gas? Densities of gases are proportional to gram-molecular weights. In order to compare the densities of gases under the same conditions one needs only to compare their molecular weights. But molecular weights can be derived from atomic weights, which students use so often that most of them are automatically memorized, or which can be taken

directly from the periodic chart.

Generalizations about solubilities will be of much help in determining whether or not a certain reaction will go to completion due to the formation of a precipitate. The periodic chart, which should be in every chemistry classroom, can be used extensively to get information about elements, compare them with other elements, study their properties, similarities, and differences.

The use of clearly stated underlying principles which are repeatedly applied greatly simplifies the study of chemistry. Such a treatment of the subject can help in developing reasoning power and arousing the scientific spirit-of-inquiry far more than the memorization of facts. This kind of training leaves in the student's mind a broad picture into which new facts may be fitted, and through which new facts may be interpreted, rather than a certain number of unrelated facts that slip easily from his memory, cannot be applied, and at best can only be repeated.

It should be mentioned here that merely explaining these principles to students is by no means a guarantee that they will understand them. Constant repetition should be utilized. The results, at the beginning, may not be encouraging but, if a principle is illustrated by a sufficient number of examples, a comprehension of its significance will ultimately be reached.

Practice, in the use of a principle, is essential.

Students of elementary chemistry must be well grounded in arithmetic and algebra. They should understand the concept of percentage and the concepts of direct and inverse relations of factors. Cancellations and shortcuts in arithmetic are very helpful, as are logarithms. All of these abilities will help in learning how to solve problems involving chemical processes.

In some classes chemistry teachers or students solve problems in a way which seems to indicate that they are trying to develop mathematical proficiency. The mathematics of secondary school chemistry is inherently not difficult, but it is often made difficult. There are certain students who have an emotional reaction against arithmetic and numbers, and many of these will not even try to solve a problem. Teachers intensify this condition by giving mathematically complicated problems right at the start. Often such problems involve a number of principles at once, and have large numbers that do not simplify or cancel easily. When chemistry problems are of the type that is mathematically difficult, the course ceases to be chemistry and reduces to arithmetical exercises, especially if the method of solution involves only the substitution of numbers in a formula. It should be kept in mind that a chemistry problem is meant to illustrate or to give insight into a certain chemical principle. Therefore, the students' attention should not be

diverted from that purpose by using large numbers and arithmetically difficult problems. Ability to work problems is presumed to be a measure of a students' comprehension. It is easy for a student with a knowledge of elementary algebra and arithmetic to substitute figures for the letters of the formula, cancel out, and find an answer without obtaining the slightest idea about the scientific laws involved.

The student should not be given merely the formula for the relation of gases, $P_1V_1T_2 = P_2V_2T_1$, Instead he should be asked to solve problems involving these relations in a way that reflects some understanding of them. The relations between volume, temperature, and pressure should be given as a first step in teaching how to solve problems involving them. Let us suppose that a given volume of gas has undergone changes in temperature and pressure, and it is necessary to find the new volume. The solution may be found thus:

New volume = old volume x temperature fraction x pressure fraction.

In figuring out the temperature fraction and the pressure fraction the student has to think in order to decide whether the change of the variable will cause an increase or a decrease in volume. This method may be applied in practically all problems commonly occurring in secondary school chemistry courses. It also applies to a large extent, in secondary school physics courses. The student should have an idea of the kind of answer to expect if he considers the change in the variables, and he

should compare his answer with this estimate.

Example: One liter of a gas weighs 1.5 grams at S.T.P. How much would two liters at 608 mm pressure and 91 deg. C. temperature weigh?

Solution:	Volume	Temperature	Pressure	Weight
	1 liter	273 deg. A.	760 mm.	1.5 grams
	2 liters	364 deg. A.	608 mm.	? grams

$$1.5 \text{ grams} \times \frac{2 \text{ liters}}{1 \text{ liter}} \times \frac{273 \text{ A}}{364 \text{ A}} \times \frac{608 \text{ mm}}{760 \text{ mm}} = 1.8 \text{ grams}$$

It saves trouble in a beginner's course if the units are always included. It should be noted that the fractions of temperature, pressure, and volume are ratios and therefore, the units of numbers in any one such fraction should be the same. Whenever one variable is considered, the other variables are held constant. For example, in the above problem, under certain conditions of temperature and pressure, one liter weighs 1.5 grams. Under the same conditions, 2 liters weigh twice as much. Hence the fraction 2 liters/1 liter. At a constant pressure, a certain volume of a gas at a temperature of 273 deg. A. weighs 1.5 grams. Under the same pressure, the same volume will weigh less when the temperature changes to 364 deg. A., because in the latter case, the molecules are farther apart so there are fewer of them in the same volume, and therefore, there is less weight. Hence, the fraction 273 A/ 364 A. For the third fraction, at a constant temperature a certain volume of a gas at a pressure of 760 mm.

weighs 1.5 grams. At the same temperature, the same volume of gas will weigh less when the pressure is changed to 608 mm., because in the latter case, the molecules will be farther apart under the reduced pressure. Therefore, there are fewer molecules in the same volume, resulting in less weight. Hence, the fraction, 608 mm/760 mm.

The above example is one of the most difficult in the secondary school chemistry course. It should be emphasized that it is better to reserve arithmetical computation until the last step toward the solution, although cancellation and simplification will help if used throughout. Emphasis upon expressing a unit with the answer, if there is one, should be made.

It was mentioned before that not all things could be remembered by understanding; some facts have to be remembered through repetition. It has been found that the use of mnemonics is an interesting and useful aid in the memorization and/or the remembering of certain facts. The following are some mnemonics:

1. Litmus paper — acid red / base blue / base blue
2. Vanadium V(Roman 5). It is an element in the fifth vertical column of the periodic table.
3. Stalagmites Ground (Emerging from the ground)
   Stalactites Ceiling (Emerging from the ceiling)
4. Alkalies (one word) Valence 1
   Alkaline earths (two words) Valence 2

From the writer's own experience it is clear that students like mnemonics, and they like to be asked to invent and apply them. Mnemonics presuppose correct spelling, as the above examples demonstrate.

In many instances the writer has found that failure on the part of a secondary school chemistry student has been due to his inability to comprehend what has been read or studied because of poor reading and studying habits. This is amply demonstrated in the laboratory of the freshman class of the American University of Beirut, where many difficulties arise and mistakes are made because of the inability of the students to interpret the English of the instructions.

Since proper study methods will improve progress, following are a few suggestions on how to study chemistry:

1. The symbols, terms, and language that are peculiar to chemistry should be mastered as they come up in the course. This knowledge is cumulative and its mastery makes study and understanding of subsequent topics much easier.
2. A preliminary survey of the lesson at hand will help to point up the relative importance of different parts of the topic, and will contribute to greater understanding of the lesson as a unit rather than as a series of isolated facts.

3. Some parts need to be intensively studied while others are not as important. Teachers are expected to help beginners in chemistry to sift out unimportant topics from important ones.
4. Reviews and summaries are important. Their value lies in the bringing together of widespread facts and theories into logical patterns, in getting new general views of units, and in forming new associations.

V. Demonstrations and Laboratory Experiences

Theoretically, learning chemistry in the laboratory is an excellent plan. But a number of objections to laboratory work may arise in the practical situation. The main problem is often the lack of a teacher who is prepared to administer the laboratory efficiently. In the schools that were visited by the writer, the largest and best equipped laboratory belonged to a school of the French system. Interviews with the teachers of that school and a study of the questionnaires they answered revealed that the students actually use the laboratory only twice during the academic year.

At the beginning of a chemistry course students usually look forward with zeal and enthusiasm to laboratory work, if it is provided at all. This enthusiasm far too often fades away after they have performed a few experiments. Students read the directions and follow the orders in the manual without being made aware of the <u>how</u> and the <u>why</u> of doing things. Teachers often encourage this "doing without understanding"--it gets the students out of the laboratory in the shortest possible time.

The government program does not mention any practical work to be done in the chemistry course. It does not encourage laboratory experience, neither directly by providing schools with well-equipped laboratories, nor indirectly by asking

questions in the public examinations that presuppose some laboratory work. The initiative in this matter has been taken by the American University of Beirut which requires secondary school laboratory experiences for entrance. The number of schools introducing laboratory instruction has been increasing in the last few years, and the labora tories themselves are improving from year to year. To be able to recommend students to the American University of Beirut a school has to provide evidence that laboratory experiments have been performed in at least one of the sciences.

The first results of this newly-emerging laboratory work show that schools need a change in their viewpoint on laboratory work as well as a change in their physical facilities. While some schools now have adequate rooms and equipment, they lack the insights necessary to make this physical investment pay educational dividends. They lack teachers who believe in the value of laboratory activities, because most of their teachers have not experienced these values themselves.

Along with the indirect control, which the American University of Beirut has taken, there should have been some direct leadership and training in the form of lectures, conferences, pamphlets, and seminars for those concerned, explaining to them the history of laboratory work, the pitfalls which they should avoid, and the relative values of different methods and procedures. It is true that the University, through its Department

of Education, makes some contribution through its teacher-training courses for science students and through the "Creative Learning" conferences that have been held in the last four years. But, not all teachers of chemistry are in a position to benefit from these. Many problems await them in the proper management of laboratory work, and they often feel that the easiest way to deal with problems is to avoid them. This results in their avoiding laboratory activity as much as possible.

There have been and continue to be many controversial discussions by educators and chemistry teachers about the value of teacher-demonstrations as opposed to individual laboratory experiments. Many schools in Lebanon have just recently started to use one or the other. Very few, indeed, are those which combine both. The writer believes that demonstrations and individual laboratory work are not mutually exclusive methods of teaching chemistry. Demonstrations and individual laboratory work should be dovetailed with each other as well as with actual classroom explanation, discussion, and teaching. The proportion of each to be included in the course depends upon the subject-matter being taught at the time, the number of years over which chemistry is taught in the secondary school, the number of students in the class, and the kind of laboratory available.

The London General Certificate of Education examination, for which quite a number of schools prepare students, assumes a certain amount of laboratory work to have been performed by

the candidates, and thus reinforces the pressure which has been exerted by the American University of Beirut. This pressure, and the fact that school owners, principals, teachers, and parents are tending to become convinced of the value of laboratory work, tends to increase the number of equipped laboratories in the secondary schools of Lebanon, and accelerates their introduction. But the fact, nevertheless, persists that this movement towards laboratory experiences has been an imposed rather than a spontaneous one. That it is not due to any change in philosophy is reflected in the way laboratories are administered, and in the way teachers and students responded about the laboratory.

From the questionnaires for students and teachers it was found that in schools following the Anglo-Saxon system 21 out of 30 schools have laboratories. In the schools following the French system, it was reported that 14 out of 27 schools have laboratories. So, in all, out of 57 schools 35 schools or 61.4% possess laboratories. It should be carefully noted here, that some schools were reported to have laboratories on the basis that there are chemicals in their lockers, or because a number of teacher-demonstrations are performed during the year. The answers to question number 11 of the questionnaire for students will clarify this.

Question number 11 stated: "Did you work in the chemistry laboratory individually, by pairs, or (there followed a blank

to be filled in)?". It is noteworthy that 46.49% of the students who answered this question chose to fill in the blank, and of these, 94.34% reported that the laboratory work consisted entirely of demonstrations done by the teacher himself. Table VI lists a breakdown of the responses to question number 11.

TABLE VI

Responses to the Question, "Did you work in the chemistry laboratory individually, by pairs, or ---?"

	Number of students	Approximate Percentage
Individually	25	22
By pairs	36	32
Demonstrations (students filling in the blank)	50	44
Other answers	3	3
Total	114	

Answers to the same question number 11, were also grouped according to schools by taking the one answer from each school which obtained a clear majority or plurality of student responses. Table VII gives the results according to this grouping.

TABLE VII

Responses to the Question, "Did you work in the chemistry laboratory individually, by pairs, or --?" according to Schools as Grouped from Student Responses

	Number of Schools	Approximate Percentage
Individually	2	5
By pairs	13	34
Demonstrations (written in response)	23	61
Total	38	

It is clear from the above that demonstrations performed by the teacher were considered as laboratory work. Also, it should be noted that the 22% of students reporting individual laboratory work, as shown in Table VI, were concentrated in only two schools. Thus 95% of the schools did not offer individual laboratory work, although 34% did offer such work to students by pairs.

The answers to question number 18 in the questionnaire for students, and number 14 in the questionnaire for teachers, about the frequency of teacher demonstrations in class are given in Table VIII.

TABLE VIII

Frequency of Teacher Demonstrations according to Teachers and Students

	Number of teachers checking the category	Approx. %	Number of Schools in which the category had a majority of student responses	Approx. %
Very often	0	0	1	3
Often	2	6	0	0
An average of once/week	16	50	10	29
Very rarely	6	19	13	37
Never	8	25	11	31
Totals	32	100	35	100

It should be noted that some schools are represented by questionnaires for teachers only, and others are represneted by questionnaires for students only. In considering the answers of students to this question it was thought better to take the one answer from each school which obtained a clear majority or plurality of student responses rather than to attempt to establish a mean position along the scale of responses. In some cases, the frequency of demonstrations referred to in Table VIII is in fact the laboratory work referred to earlier.

One difficulty seems to be the physical set-up of the class-

room and the laboratory. In most schools, there is no special room for teaching the sciences in which a demonstration desk could be set up, nor are there closets, water and drainage systems, burners etc. This is one reason why the teacher cannot perform his demonstration at the psychological moment, but performs it a few days later or earlier, if at all.

Demonstrations should be well prepared and should be tried before class, because if they fail a number of times the respect of the students for the teacher's ability begins to be lost. Preparation is likely to be inadequate when the classroom in which chemistry is to be taught has been occupied by another class immediately before the chemistry class. It is better, where space is at a premium, to schedule the chemistry class after recess, or in the first period in the morning or afternoon, thus making it easier for the conscientious chemistry teacher to prepare his demonstrations. Even so, the apparatus and equipment often have to be taken away at the end of the period. If the teacher has to teach another class immediately, he cannot take the things himself, and this raises further problems. It should be noted here that the more a teacher is faced by such difficulties, the greater is the number of excuses which he can give to himself and to others for failing to perform demonstrations. It is necessary to convince the principals of schools that science teachers in general, and chemistry teachers in particular, need

time to prepare and remove their demonstrations, and that this should be taken into consideration in planning the schedule for classrooms and the loads of teachers.

Question number 10 in the questionnaire for students asked, "Did you have regular periods every week for chemistry laboratory work?". Out of 30 schools represented in the answers, only 16 were reported as having regular weekly laboratory periods. It should be noted that the schools that could answer this question are presumably the ones that do in fact have laboratories. In some cases, the regular period is for a demonstration by the teacher in a room other than the classroom. The answers to question number 4 in the questionnaire for teachers, which is a similar question, agree closely with the above on the regularity of laboratory periods.

A few questions were intended to reflect the condition of the existing chemistry laboratories in the secondary schools of Lebanon. Thirty-two schools were represented in question number 9 in the questionnaire of students, "How would you rate that laboratory?". Again, answers to this question were grouped according to schools by taking the one answer from each school which obtained a clear majority or plurality of student responses.

A breakdown of the answers is listed in Table IX.

TABLE IX

Responses to the Question, "How would you rate that laboratory?" Giving Numbers of Schools Grouped From Students' Responses

	Number of Schools	Approx. %
Excellent	2	6
Good	7	22
Fair	17	53
Poor	6	19
Total	32	100

Regarding the ways in which laboratories could be improved (the answers to question number 12 in the questionnaire for students, and number 19 in the questionnaire for teachers) the most frequent answers in order of their importance run as follows:

1. More apparatus and equipment.
2. More space or a larger laboratory.
3. A better arrangement of the physical facilities in the laboratory.
4. More and longer laboratory periods.
5. A laboratory more accessible to students.

Question number 20 in the questionnaire of students asked, "Did you perform experiments by following instructions from the

laboratory book word by word?". The one answer from each school which obtained a clear majority or plurality of student responses was considered for the school. The answers are listed in Table X.

TABLE X

Responses to the Question, "Did you perform experiments by following instructions from the laboratory book word by word?" Giving Numbers of Schools Grouped From Students' Responses

	Number of Schools
Yes	9
Sometimes	2
No	4
Total	15

Although 32 schools were represented in the responses to the question cited in Table X about rating the laboratory, only 15 schools are represented in the above question. This reflects further the misconception of laboratory activity by students of these schools.

A laboratory experiment in which there is not some student planning, observation, thinking, and conclusion, ceases to be a laboratory experiment in the proper sense, and defeats its purpose. In many schools, students follow instructions from the laboratory manual in the laboratory in the same way a cook follows

the instructions of the cook-book in the kitchen. Although laboratory work is recommended strongly to the secondary schools of Lebanon, it will not be worth the time, effort, and money if it leads only to failure. Laboratory experiments, when they are problems and questions for which answers are sought, when they are truly experiments, are exciting; and, as such are powerful motivational tools.

"Are the students graded for their laboratory work?" was question number 18 in the questionnaire of teachers. In answering, 14 teachers said yes; while, 8 said no. Those who answered "yes" were asked to give an estimate of the percentage of the total grade which is given for laboratory instruction. The percentage given in the answers ranged from 10 to 50%, with a mean of 25.85%.

Students in the laboratory are not encouraged to be honest in their observations. This is primarily because teachers base their grades mostly on the reports submitted and the results included. For example, in a certain experiment, to find the percentage of oxygen in the compound potassium chlorate, some students reported results as close as 39.20% (the correct value being 39.18%). The chemical analyst himself could rarely come out with such a close result using crude classroom balances.

It is the writer's belief that there should be no grade based merely on the numerical results of experiments in the secondary school, nor even in the freshman classes of universities,

Students should be encouraged to perform experiments objectively, observe what is happening and not what is being expected to happen. It is best when the teacher concentrates on the technique of the students; when he moves about freely, asking students the "how's" and "why's" of the experiment.

Some laboratory manuals ask factual questions at the end of the instructions for an experiment--questions which could be answered beforehand by referring to the text. It would be better if the questions were more closely related to the laboratory experiment itself, and if the answers to those questions could be drawn from the experiments. There is often much overlapping between the text-book and the laboratory experiment. Whenever possible, it is best to avoid questions whose answers can be written without doing the experiment.

Apparatus and equipment in the laboratory need not be perfect or arranged to require the minimum amount of work for students. In one classical experiment, the preparation of oxygen from potassium chlorate, which was to be performed by pairs of students, a group of students was confronted with delivery tubes and pieces of glass tubing, together with the other equipment that was to be used. Some of the students complained about the lack of delivery tubes. They were asked to think of a substitute. It was thrilling to both students and teacher when one student took a piece of rubber tubing and joined two pieces of glass tubing, forming a more adaptable delivery tube than the first one.

It is sometimes said of a lecture that it goes directly from the note-book of the teacher to the note-book of the student without passing through the mind of either. Similarly, the laboratory manual or note-book may have all the right answers, while the student's head may have none. The teaching of chemistry through demonstrations and laboratory experiences should inculcate in the student a method of thought, a skill in accurate observation, and a skill in the drawing of sound conclusions.

The typical secondary school laboratory asks the students to follow instructions and to imitate rather than to engage in critical thinking. It is easy to criticize, but it is difficult to make suggestions for improvement which will be suitable for every laboratory, with every teacher, and with all types of students. Many secondary schools are trying laboratory instruction for the first time. Others are on their way to starting it. The suggestions that the writer will make are by no means final or rigid, and are not expected to work in all situations. The suggestions are views which, if not accepted as they are, will at least, it is hoped, provide starting points for development, and improvement. The following are some suggestions pertaining to laboratory experiences for students:.

1) First, all secondary schools in Lebanon should strive to have well-equipped laboratories and try hard to secure teachers for the sciences who are capable and ready to

use these facilities to the maximum. Teachers of chemistry are expected to know more about laboratories than school principals and administrators, and it is their duty to make known the need for well-equipped laboratories. It would seem desirable to have the laboratory as close to the chemistry classroom as possible. In smaller schools, large rooms, in which the laboratory occupies one part and the class another, may be suitable. This makes the laboratory accessible to the teacher, facilitates his work, and reduces the changes of his neglecting demonstrations.

2) Second, the teacher should dispense with most experiments appearing in the laboratory manuals. He should not allow the students to become slaves to the laboratory manual. If possible he should make use of several different laboratory manuals. He should use his own creativity, or ask students to present problems which they want to have studied, and utilize these as the core of laboratory activities. Many teachers do not like the experiments or the questions in the laboratory manuals, Often, the school does not possess the required chemicals. A set of experiments should be prepared which will suit the existing conditions and leave room for creativity on the part of the students. This requires more time on the part of the teacher in the first year, after which it should reduce itself to modification of the experiments in the light of their workability. A teacher can find much satis-

faction in experiments which he has devised himself. They mean more to him than experiments prepared by others, and the students can feel the teacher's personal interest while they are doing the experiment. When the experiment is finished, the teacher should ask the students how it could have been improved. In order to suggest improvements in an experiment the student must look for weak points in the one he is doing, and this requires reflection and understanding.

Students in one class had difficulty in grasping the meaning of the concepts of normality and molarity. As a result, the planned experiment for that week was postponed, and an experiment on molarity and normality was substituted. Each student was orally asked to prepare a solution of a certain molarity or normality. Example: Prepare 250 milliliters of NaOH which is 0.1 Normal. The student had to calculate how many grams of NaOH he needed. But students could not have exactly the calculated weight because it is difficult to cut the NaOH into very small pieces, NaOH being corrosive and deliquescent. They were allowed to weigh it as close to the calculated value as possible. Then, they had to make a separate calculation to find the normality based on the weight they had actually taken. Each one had to label the solution, and to put his name on the label. In the following laboratory period each student gave his labelled solution to another student. Through the use of a burette and a standard solution, the second

student checked whether or not the labelling of the concentration was correct. Quite a number of disagreements followed, and in a number of cases the student who was believed to have made a mistake performed the titration for his solution himself. It is easy to imagine how much his technique improved.

3) On the first day, the teacher should familiarize students with the apparatus, its proper use, and the rules for laboratory work, including safety precautions, proper methods for disposal of wastes etc.

4) The teacher should take all necessary steps to eliminate hazards in the chemical laboratory.

The chemical laboratory is a potential source of accidents. Laboratory work is a great responsibility, and this may be one reason why many teachers try to avoid it. Teachers should be well-trained and informed about laboratory safety. It is unfortunate that such training is absent in teacher-training centers in Lebanon. It is the duty of school authorities, and chemistry teachers to take into consideration the inexperience and the immaturity of students in secondary schools. This does not mean eliminating the laboratory. It means, however, that a laboratory without adequate safety precautions is worse than no laboratory at all.

Teachers should realize that young chemists in secondary school laboratories will sometimes be too scientific. They will want to check whether or not the book's warning against

a certain procedure is valid. There is no substitute for eternal vigilance on the teacher's part.

Teachers should always familiarize themselves with possible hazards and the means of avoiding them. The student should be told what the real hazards are, clearly and without undue emotion. Some teachers go so far in their preventive measures that they give students an irrational fear of chemicals and chemical experiments. One of the purposes of laboratory instruction is to expose students to the unvarnished truth.

The following are some suggestions for safety in chemical laboratories:

a) The laboratory should be supplied with emergency equipment such as fire extinguishers, safety showers, and woolen safety blankets, folded in a way which permits immediate unfolding. These and other precautions, such as having doors opening outward, should be an integral part of the design of a good laboratory. A demonstration on the use of these should be given at the beginning of the year. A first aid chart and cabinet are essential.

b) Before every new experiment all possible hazards should be pointed out by the teacher, and ways to avoid them should be made clear to the students. Students should never be allowed to perform unauthorized experiments. They should understand from the beginning that they may

devise and plan their own experiments provided that these are submitted to the teacher for approval at the proper time.

c) Storage of chemicals. - All inflammable, poisonous, explosive, or otherwise dangerous chemicals should be stored separately under lock and key. The teacher should be sure that yellow phosphorous sticks are always completely covered with water; that metallic sodium or potassium are protected against moisture. Also, all chemicals should be accurately labelled. The teacher should be sure to buy his chemicals from a reliable source with proper labelling and instructions, and should not be attracted by cheap materials.

d) The teacher should use a safety screen in demonstrations and, if necessary, wear goggles and make sure that the room is properly ventilated. Hoods are desirable whenever poisonous gases are to be prepared. In their absence the preparation may be safely conducted out of doors.

e) .When schools start using the laboratory on a larger scale, it is probable that some accidents will occur. Despite the fact that it may involve one chemistry teacher's pride, it is beneficial to other schools to receive reports indicating what has happened in school "X", what the specific mistake was, and what should be

done to prevent its recurrence.

The fundamental principles of chemical safety are not learnings which are applicable only in the laboratory. They find many applications in the home, for example, in the use of gas and other kinds of heaters and stoves, in realizing the hazard of taking medicine from unlabelled bottles, in accidents of asphyxiation etc.

5) The teacher should not emphasize theoretical values in the results of laboratory experiments. He should stress objectivity and honesty in reporting. Whether or not the student arrives at correct answers should be of minor importance in the secondary school laboratory. It is the method followed, the honest recording of the happenings, and the drawing of conclusions that should count. If there is considerable error, the student may be required to discover the reasons which led to this error.

The students should not be given the erroneous idea that they can produce perfect results in the secondary school laboratory. They should know that they will not be penalized if their results are imperfect but honest. It is easy for them to find the "approved" outcomes of some experiments by working a problem backward, by referring to the text-book, or by referring to the papers of students who have taken the course

previously. The use of teacher-prepared "unknowns" is a good method for encouraging self-reliance and accuracy of observation in students.

6) The teacher should provide, through the laboratory, opportunities for students to be creative and to use their initiative. He should give the students the main idea of the experiment, cautioning them against possible hazards, and let them devise their own methods, and solve their own problems. Some students were performing a distillation experiment using a water condenser. There were not enough taps of water for all the condensers. One student said that he could not do the experiment because of this. When he was asked to find a solution to his problem, he ended by pouring water into a funnel leading to the condenser. A few minutes later he got so tired of holding the funnel high that he thought of another solution. He connected the exhaust water from another student's to his own condenser. This worked very well, and he was very pleased at having successfully solved his problem. To the extent that we give students the experience of successful problem-solving, we contribute to the permanence of scientific thinking in their lives.

In the laboratory the teacher and the student come into close contact, and it is in the laboratory that teaching can be done most effectively. It is also a good time to study the difficulties of students, their weak and strong points, their

interests etc., in order to guide them. It is best, whenever possible, to have students work individually because many students depend on others to do most of the work and will take the role of onlookers when they work in pairs or in larger groups. When they work individually, they will be trained to depend upon themselves. For example, some students are afraid of bunsen burners and they will avoid lighting them by asking others to do it for them. The teacher should insist that every student know how to do well and confidently all of the routine laboratory operations.

It is much better if there are not too many students in the laboratory, so that the teacher can pay individual attention to each student, and can have them all under his eye in order to reduce the hazards of the laboratory to a minimum. In addition, the teacher should watch and compare the reactions of different students to experiments, take notes on what bores them as well as what makes their eyes glitter with interest, so that he can plan modifications of the course. A teacher should not use his time in the laboratory for correcting test papers, adding grades, preparing the following day's demonstration, reporting absences, or reading a newspaper. He should pass from student to student, asking questions, helping students, checking apparatus etc. This is the time when the teacher can know his students much better, and can reliably estimate the students' knowledge and ability. The best time is certainly

not at the end of a written test about the laboratory experiment.

Suggestions specific to class demonstrations:-

Demonstrations are essential because, in order to teach a chemistry course efficiently, students should be made to see chemistry in action as much as possible, and not just hear and read about it. In some Lebanese secondary schools, demonstrations and laboratory experiments are left to the top class. This appears to be an inverted idea, because in a subject like chemistry, the less a student knows about it, the more direct observation he needs.

Demonstrations alone will not develop manual skills. But thinking can be developed, and interest can be aroused, and better understanding may take place as a result. The apparatus should be as simple and familiar as possible because complicated and unfamiliar apparatus confuses students and distracts their attention from the main features of the experiment.

In performing demonstrations the teacher should do his best to see them from the view point of the students. Demonstrations are best when done with enthusiasm. The teacher should enjoy them and should show his pleasure in doing them. He should avoid distractions because the value of a demonstration may be lost if anything is allowed to distract attention at the critical moment. The results of demonstrations should be seen by all students. The essential points should

be called attention to. Equations should be worked out, and applications of the demonstrations should be cited and discussed.

Demonstrations are worth doing only when (a) the students really see something happen, (b) the connection between what is seen and the explanation or interpretation is comprehensible to them. It is the teacher's task to keep the students thinking during a demonstration. Carefully planned questions are very useful for this. Otherwise, it will be reduced simply to process of watching without reasoning. The students should be encouraged to examine the apparatus and samples of the materials used after the demonstration is over.

In conclusion, the student should be helped to attain an insight into the methods by which science in general, and the science of chemistry in particular, has achieved its status. The student should be offered opportunities to devise experiments, to tap his potentialities in science, to make use of his mind and his senses both while working in the laboratory and while observing a demonstration. Mere presence in a laboratory is no assurance that a student will grasp the role of scientific methods in problem solving. The understanding of scientific methods calls for more than the manipulation of materials and the verification of text-book information. The way the laboratory is administered, the way the student is faced with problems, and the way the student is directed in solving

these problems is what is important. All of these can contribute to the establishment and the development of the attitudes and habits of scientists.

VI. The Utilization of Audio-visual Aids and Other Activities.

Audio-visual aids comprise materials and techniques that appeal to the senses of the learner, especially those of hearing and seeing. In the secondary schools of Lebanon the use of audio-visual aids in the teaching of chemistry is limited, judging from the results of this study. The answers of 132 students to question number 15 in the questionnairs, "Did the teacher use films, charts, graphs in his teaching?" are shown in Table XI.

TABLE XI

Number of Student Responses on the Use of Films, Charts, and Graphs

	Number of Student Responses	Approx %
Films	6	5
Charts	22	17
Graphs	13	10
None of the above	99	75

The above figures show that 75% of the students who answered the question did not see films, charts, or graphs, in their chemistry classes.

Most chemistry teachers in the secondary schools of Lebanon are aware of the fact that most students in the secondary schools do not like chemistry, primarily because they do not understand it, and because they are not properly motivated.

To arouse interest in the students and to impress them calls for materials and techniques that have a common appeal and that are stimulating.

The use of audio-visual aids is an innovation for educational institutions in Lebanon. If the schools are asked why they do not make more use of audio-visual aids, the usual answer is that not enough money is available. This may be partially true, but, surely, it is not true in all cases. A number of schools own movie projectors which are not used in the classrooms. They are usually used to show films for their entertainment value, and any educational benefit is purely accidental.

The secondary schools of Lebanon should prepare their teachers for the use of audio-visual aids. This may be done through talks, conferences, courses, pamphlets, and periodicals which will help teachers to understand the value of audio-visual aids and to master their methods and techniques. Without this there will be little if any point in purchasing equipment. For the proper use of audio-visual aids the teacher should be really convinced of its value. He should be flexible

and open-minded in his methods and should be ready to use every item that may help in the teaching process. The value of audio-visual aids as very important tools for course enrichment is now widely accepted.

In answer to question number 17 in the questionnaire of teachers, "Do you have the following materials in your school?", the answers of 36 teachers run as listed in Table XII.

TABLE XII

Teachers' Responses About Certain Audio-visual Materials Possessed by Their Schools

	Number of Teachers	Percentage
A movie projector	15	41.7%
Chart (periodic table)	17	47.2%
Demonstration table in the classroom	12	33.3%

There are no film libraries for the use of secondary schools which are available for strictly educational purposes. The following is a list of film libraries in Beirut which offer films useful for the secondary school chemistry course:

1. The British Council
2. The Indian Information Service
3. The Canadian Embassy

4. The Shell Company

5. The United States Information Service.

During the summer of 1956, the individuals concerned with the film libraries in the U.S.I.S., the British Council, and the Indian Information Service were interviewed by the writer regarding their services. The records in the film-section of the British Council revealed that, during the academic year 1955-56, film services were offered to 31 schools in Lebanon. From the names of these schools it was found that both those of the French and of the Anglo-Saxon systems were represented. One government school was also included in the list. It was understood from the responsible individual that very few of the films borrowed by these schools were science films. Also, quite a number of these schools do not use these films in classrooms. Many of them are borrowed for purposes of entertainment.

From the U.S.I.S. film library, 15 schools were reported to have borrowed scientific films during the academic year 1955-56. And from the Indian Information Service, 6 schools were reported to have used scientific films during the same academic year, 1955-56.

Some of these film libraries are ready to provide projectors and projectionists to schools if enough notice is given (usually about one week in advance if a projectionist

is needed). Although quite a number of schools were represented as making use of films provided by these film libraries, it should be mentioned that the over-all frequency of the utilization of films by schools is low.

The British Council and the U.S.I.S. also have filmstrip libraries. The use of filmstrips by the secondary schools of Lebanon is even less frequent than the use of films.

It is strongly recommended that film libraries, which are strictly educational, should be established for the benefit of academic institutions in Lebanon. It might be practical to have three film libraries. One owned by the government to be used mainly for the benefit of government schools, another centered at St. Joseph University mainly for the use of non-government schools following the French system, and a third centered at the American University of Beirut for the benefit of schools of the Anglo-Saxon type. The benefiting schools, the institutions to which the libraries will be affiliated, the government, and, if possible, other organizations might share the burden of the establishment and the running of the suggested film libraries. The above suggested division is for convenience, and it is expected that the three film libraries will cooperate widely. Some of the existing private film libraries might contribute some of their educational films to such libraries.

Films and film-strips are but two of many aids which teachers in Lebanon may call upon. Models, posters, exhibits,

recordings and assembly programs are others. Credit should be given to the Education Department in the American University of Beirut for organizing the "Creative Learning" conferences in which a number of secondary schools in Lebanon take part. This has made many contributions to the professional growth of teachers through informal contacts with other teachers and university professors. There seems to be a healthy competitive spirit among schools for originality in their projects and exhibits. It is unfortunate that only about twenty schools have so far been represented in the conferences.

The teaching of secondary school chemistry may be greatly enriched through appropriate use of projects in teaching. Pupils are required to use their initiative and resourcefulness in thinking of projects and carrying them out. A project should not be a heavy burden imposed on the student. He should be asked to choose as a project something that interests him. Models, chemical processes, preparation of commercial substances such as soap and cosmetics, water softening, blowing and etching glass, and unusual experiments are a few examples.

A well-organized assembly program is usually well-received by the student body. Certain definite outcomes should be expected from a well-planned assembly program in chemistry. Much benefit, educationally speaking, is undoubtedly gained by the chemistry students taking part in the program. The students should assume the major role in the organization and the per-

formance of an assembly program. The writer usually asks his students to present suggestions for an assembly program. When the suggestions are submitted, a committee is elected by the students to weigh these suggestions, sift them, and decide on the organization for the program. The teacher acts as an advisor to this committee. Once the main idea is crystallized, and the demonstrations to be performed decided upon, the various roles are distributed among the students. As many students as possible should participate in the preparation and the presentation of the program. The program should be adapted to the audience's science and chemistry background. Whether the program is primarily entertaining or primarily educational to the audience depends upon the purpose, but it is undeniably an excellent learning experience for the students taking part in it.

The teaching of chemistry involves much drawing of diagrams for apparatus and processes. It may be very helpful for the teacher to make use of certain aids like templates in the drawing of diagrams, sketches, and curves. The use of charts, especially, the periodic chart of the elements, is very helpful in simplifying, clarifying, and relating many facts about the elements and their properties. Posters, advertisements(educational), and clippings can often be used on the bulletin board with benefit. It is the writer's belief that it is beneficial to stimulate supplementary reading by requiring written reports on scientific

subjects of interest at least twice during a chemistry course. There is a great deal of satisfaction on the part of the student who suddenly discovers that, as a result of the chemistry course, he can read scientific articles intelligently.

Some teachers use audio-visual aids just for the sake of using them. They show films that do not fit into the lesson, the age level of the students, or their background. To utilize audio-visual materials effectively the teacher should prepare the class for them, carry out the activity, and evaluate the results through class discussion. He should use them critically with full realization and awareness of their functions, advantages, and limitations.

VII. Evaluation and Examinations

Many of the complaints of students about chemistry centered around the fact that teachers place a strong emphasis on rote memorization. Teachers feel that this stress on memorization is justified in large part by the kinds of questions asked in examinations. Examination questions constitute an indirect way of appraising the philosophy of education of the teacher giving the examination. In the modern view, the importance of examination questions lies in their power as educational tools for directing students' thinking and study habits into certain patterns. Bossing, in his Teaching in Secondary Schools, states that "educators are just becoming aware of the potential value of the examination as a means of guiding the student into correct study habits".(13)

Many of the criticisms of the teaching of chemistry in the secondary schools of Lebanon were traced back to the government examinations for which students are required to sit if they look forward to higher professional education or to the better government positions.

Question number 28 in the questionnaire for students states, "were the efforts of the teacher directed towards having you pass a certain examination?". The results are listed in Table XIII.

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(13) Bossing, N.L., P. 247.

TABLE XIII

Students' responses to the question, "Were the efforts of the teacher directed towards having you pass a certain examination?"

	Number of students	Percentage
Yes	61	52.1%
No	56	47.9%
	Total 117	

The following are the current general examinations for which the secondary schools of Lebanon prepare their students:

1) The Brevet public (government) examination at the end of four years of secondary education, which follows the primary cycle of five years.
2) The Baccalaureat Part I examination at the end of the sixth year of secondary education. This examination is taken in one of three fields: literary, scientific, and ancient languages. Each has an oral and a written part. In the oral part of the literary section the examination includes one question on chemistry and physics. No chemistry or physics is included in the written part.

The scientific section includes physics and chemistry in both its written and oral parts which together con-

stitute 3/10 of the point value of the examination. The examination covering the field of ancient languages does not include any physical science.

3) The Baccalaureat Part II examination, at the end of the seventh year of the secondary education, is divided into two main sections: Philosophy and mathematics. The written part of the examination of the philosophy section in the sciences includes three questions from which one must be chosen, and one compulsory question. Of this examination in the oral part, one question is asked in the physical sciences. In the mathematics section, the four-hour written examination in physics and chemistry and the one question in the oral part constitute together 3/10 of the value of the examination.

The government examinations are open only to Lebanese students. This means that schools enrolling non-Lebanese students must generally ignore the differing requirements of the non-Lebanese.

Points from 0 to 20 are given in each examination. A student who gets a zero in any examination or who gets less than 5 points in the Arabic language part will fail the examination. To be eligible for the oral part of the examination a candidate must have secured at least half of the maximum number of points possible in the written examination. A trans-

lation from the French of the science examination of the second cycle of the Part II Baccalaureat examination of 1956, philosophy section, together with a copy of the French original, is cited in Appendix C. A table showing the number of students who sat for the Brevet, Baccalaureat Part I, and Baccalaureat Part II examinations for the years 1951-55, with the percentage succeeding, is also given in the appendix.

4) The French Baccalaureat examinations, for which students in some Lebanese schools prepare, are parallel to the Lebanese Baccalaureat examinations in their parts and requirements, with the exception of the Arabic language. Students who pass the French Baccalaureat examinations enjoy the same privileges as those who pass the Lebanese Baccalaureat, for the two are considered equivalent.

5). As for the General Certificate of Education examination about 10 or 11 secondary schools in Lebanon are usually represented in it. In Lebanon, this examination is usually given twice each year (in summer and autumn) by the British Council. Table XIV shows among other things the percentage success of candidates in the chemistry part of this examination:

TABLE XIV

Results of the General Certificate of Education Examination

Type of Examination	Year	Number of Candidates	Number Passed	Percentage of Success
Ordinary level	1954	52	15	28.8%
Advanced level	1954	4	0	0%
Ordinary level	1955	66	17	25.8%
Advanced level	1955	1	0	0%

6) Other examinations for which students sit include those organized by the American University of Beirut, including aptitude tests for prospective University students and entrance examinations for students who are not otherwise admitted to the University.

An informal interview with about 80 students graduating from the secondary schools of Lebanon has shown that much cheating takes place in the examinations in the secondary schools, particularly in the classroom tests, and that there are many successful attempts at cheating. It was further reported that answers to different questions are written before hand on separate sheets of paper for the purpose of cheating. This kind of preparation for the test is promoted by the fact that the type of questions asked require memorization. This cannot take place

when the questions devised depend upon understanding.

The right kinds of questions are excellent tools in good chemistry teaching. "What happened", "Why", and "How" are invaluable questions in teaching chemistry. Unfortunately, in the secondary schools of Lebanon, in general, questions that are used encourage students to memorize rather than to understand. A chemistry course in the secondary school necessitates the learning of facts, it is true. But fewer facts woven into a fabric of relationships and generalizations, make of the mind a sharp and powerful tool. At best, facts alone make a storehouse of the mind, where even the materials stored gradually evaporate with the passage of time.

An important determining factor affecting the methods of both teachers and students is the government examination system. One of the Baccalaureat Part II examinations, mathematics section, had a question in which the student had to write about one of the following: 1) Picric acid, 2) Glycol and glycerin, 3) Aniline. The student had to write all he remembered about the subject he chose. He is probably expected to follow a certain development of the topic, such as found in text-books. This question measures how much of a particular topic the student remembers. The questions are taken from one or two chapters in the chemistry book. If the student does not happen to know these one or two chapters very well, it gives the impression that he knows little chemistry, even when he knows all the other

chapters well. This type of question, the essay type, does not tell the candidate how extensively he is supposed to write about the topic. Many students develop the habit of simply answering everything they know which is even remotely related to the question. Responses to essay questions require skill in the use of the language and they require legible handwriting. Proper answering of an essay question also requires planning and organization. All these factors, which have little to do with chemistry proper, are determining factors in passing or failing a student.

Another disadvantage of the essay question is that the grade given to the response is heavily dependent on the subjective evaluation of the examiner who corrects the paper. This procedure has been shown to be highly unreliable, especially when there is more than one examiner correcting papers in a general examination.

The high rate of failure in the Baccalaureat examinations reflects a definite weakness somewhere. The weakness could be in the preparation of the students or in the examination itself, or in both. The writer believes that it is in both. The examination itself is not fair, and does not adequately measure what the student has actually learned. It would be better if the emphasis in examinations were shifted from an examination requiring memorization of facts to an examination requiring an

understanding of relationships. The percentage of success is already so low that it is unlikely to change for the worse. With this shift of emphasis, even failing students might come out with some understanding of, and liking for chemistry.

From the suggestions of the students queried in the questionnaire, the writer suggests that more emphasis should be placed on chemistry in the Baccalaureat examinations, especially in the literary section of Baccalaureat Part I. As long as students are held responsible for learning chemistry it should be tested properly. The main concern of students in the higher secondary classes is to pass the Baccalaureat examination. Since chemistry is not being sufficiently emphasized in the questions, little attention is being paid to it. Teachers emphasize physics more than chemistry because physics is emphasized more in the physical sciences examinations of the Baccalaureat.

These examinations which have restricted the freedom and the initiative of teachers, and which have encouraged pure memorization should be abolished or totally changed. What is needed is an examination which measures, in so far as chemistry is concerned, the achievement of students in light of the aims of the teaching of chemistry.

In the classroom, tests can be used for diagnostic purposes; to grade students; to discover their weak and strong points; and to stimulate students' efforts. The test can serve as a teaching

aid by bringing to the students' minds the important points in the course and enabling them to discover and recall relationships. Tests help in discovering the difficulties encountered by a class.

Students should have an idea of what kind of an examination to expect in order to reduce the fear and worry that are generally associated with tests and examinations. After a test the papers should be given back to the students in the shortest possible time. Their points of view about the questions, the corrections, and the grading should be taken into consideration as long as they are well-meaning. The most common mistakes should be discussed in class and clarified. It is advisable to repeat questions involving the most common mistakes in subsequent tests.

School examinations are often miniatures of the government examinations, since this is one way of preparing for them. Imagine that a student has learned all about the physical and chemical properties of carbon monoxide. A real test for this knowledge should be functional and not verbalistic. "How would you react if you found yourself in a closed garage with the motor of a car running, and why?" is a functional question as compared to the verbalistic one; "List the physical and chemical properties of carbon monoxide". As Orval Petersen has put it, "How much man knows about the world in which he lives is not

nearly so important or significant as to what uses and purposes he applies the knowledge he has",(14)

(14) School Science and Mathematics Vol. 56, No. 4, p. 302, April 1956.

VIII. Suggestions Relating Chemistry Teaching to Daily-life

Much has been said about the large influence of chemical products and processes on the daily-life of the people. It is unfortunate that this influence is mostly indirect and that the majority of students do not perceive any tangible benefits from their secondary school chemistry course. Most students find this course difficult and uninteresting because the subject-matter seems impractical. Teachers should compensate for this fallacy by bringing into classroom discussions topics which show the direct effect of chemistry on the daily-lives of their students. The following paragraphs are suggestions which a teacher may use to create more interest in the course. For many of the ideas, the writer is indebted to LeVesconte for the article on "Adapting Elementary Chemistry to Girls' Interests",(15) and to Rawlins and Struble.(16)

It is precisely because chemistry finds practical application in many phases of home life that home economics students are usually required to study it. Units of volume become more meaningful when the liter is compared to a certain number of glasses of water (with the comparison actually done in class), and when the capacity of a teaspoon is compared to a cubic centimeter or a milliliter. An understanding of the unit called

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(15) Journal of Chemical Education, 9:1620-24, 1932
(16) Op. cit.

a calorie will help students to grasp the idea behind the amount of heat yielded by the oxidation of foods in their body. Dilute and concentrated solutions may be compared to sweetened water and thick sirup. The effect of pressure on the boiling point of a liquid is readily illustrated by reference to the pressure-cooker. The effect of the concentration of an electrolyte and non-electrolyte on the freezing points of water can be illustrated by using a salt and a sugar solution respectively in freezing ice-cream. The difference in time needed for an egg to become hard boiled in boiled salt solution will illustrate the principle of raising the boiling point of solutions. The function of gelatin in ice-cream as a protective colloid to prevent the formation of large crystals of ice can be illustrated by preparing ice-cream with and without the use of gelatin. Different methods for the preservation of foods such as those used to preserve raisins, bacon, jellies, and jam should become familiar. The phenomenon of absorption is illustrated by the use of fine powders to remove stains.

Knowledge about disinfectants, insecticides, baking powders, combustible substances, what makes butter rancid, what sours milk, the removal of stains, the tarnishing of silverware, and the purification of water for drinking purposes--all these help greatly in leading a more intelligent life, and make the pupil feel that he has been given tools for the better understanding and control of his environment.

Baking powder can be used to perform experiments and to explain topics related to many chemical principles. Leavening is essentially a means for generating carbon dioxide within a dough prior to and during the earlier stages of its baking. Baking powder is an example of a mixture. It contains dry sodium bicarbonate and a dry, edible, solid which is acid-reacting. The acid reacting materials in baking powders are usually tartaric acid or its acid salts. Acid salts of phosphoric acid or some compound of aluminum may be used. The mixture is diluted with dry starch. Moisture and high humidity, as found in Beirut, will cause the deterioration of a baking powder because it decomposes in the presence of water. Therefore, a good container is essential to baking-powder stability. The starch used serves as a desiccating material in the powder, and also to regulate the rate of the evolution of the carbon dioxide. The action of sour milk on the sodium bicarbonate of the baking powder illustrates the general principle of the action of acids on carbonates. The subject of ionization may be started from the fact that it is necessary to add water or milk to start the reaction of a baking powder. One of the acid-reacting substances used in baking powders is aluminum sulfate. The study of the principle of hydrolysis can be started by observing the acidic properties of this salt when dissolved in water.

The old adage, "an ounce of prevention is worth a pound

of cure", is applicable to our daily-life in so far as health problems are concerned. Proper use of drugs and other chemical compounds and an understanding of their function and uses can be helpful in fighting disease and in preventing poor health. The functional study of poisonous gases and their properties should contribute to a reduction of the accidental deaths caused by them. Carbon monoxide is the most common gas causing accidental deaths. The most common sources are fuel gases, automobile exhausts, and gas from coal stoves and heaters. Other causes of health accidents due to chemicals or to accidents in which lack of chemical knowledge may be a factor are: mistaking poisons for medicines by using unlabelled containers; overdoses of medicines; carelessness of parents in having medicines or poisons available to children; mistaking denatured alcohol or wood alcohol for grain alcohol; mistaking a tincture of iodine for an eye medicine; the inability to interpret instructions for the proper use of medicines and antidotes; food poisoning due to products of decay or growth of organisms in foods; burns and fires due to improper methods of using fuels; the inability to put out a fire due to a lack of knowledge of the nature of fire; the solubility of lead in soft water and the cumulative poisoning caused by lead; the effect on the skin of gasoline containing tetraethyl lead; the electrical conductivity of water on the hands due to the salts on the skin that dissolve in it; the use of a baking soda or ammonia water to neutralize the

acid injected by the bee.

Other topics that have direct applications to one's every-day life are represented in the following questions: What is the meaning of the octane rating of gasoline? What is the difference between denatured alcohol and grain alcohol? What are narcotics and vaccines? Why is alcohol used in automobile radiators? How can water be purified? How is carbon dioxide used in soft drinks? What are the impurities in water and how may they be removed? What factors raise the rate of solution? Why is sodium carbonate used in washing powders? Why is ammonia water more desirable for removing grease spots from fabrics than sodium hydroxide solution? How is tarnish removed from silverware? For what particular insects is DDT deadly? What are the essential of a wholesome diet? How is soap made and how does it function as a cleansing agent? Why is toast more digestible than bread? What is a tincture of iodine? How can various stains be removed from clothes made of different materials?

Text-books cannot by themselves, constitute an inspiring course in chemistry. They should always be supplemented by the teachers' experiences. If teachers bring to the classroom newspapers and magazines in order to evaluate intelligently with the whole class the advertisements that deal with chemical phenomena, the chemistry course will become more meaningful.

Teachers should bring to class bottles of chemical products, and let students read the directions, interpret them, and use them whenever possible. Students may evaluate various brands of vinegar; various kinds of olive oil for acidity; and the various kinds of washing powders.

The above paragraphs show that chemistry touches directly many phases of the lives of people. It will be the duty of the alert teacher to think of numerous ways of introducing the practical applications of chemistry in his course.

IX. The Chemistry Teacher

"Good teachers constantly work to improve their teaching. That is why they are good."(17) Many teachers of chemistry in the secondary schools of Lebanon have outside jobs. Others are overloaded. Both these factors do not leave time for self-improvement. Many teachers say that in their busy days they have no opportunity to prepare for effective teaching. Teachers use the out-moded, traditional methods of teaching because these methods are easy to apply and will save time and energy for their other jobs.

All the suggestions which have been presented in this study will be of little value in the absence of an efficient and enthusiastic teacher. From a social point of view teaching is not valued highly in Lebanon. From the writer's observations at the American University of Beirut for the last seven years, it is clear that many students start by preparing themselves for engineering or medicine. Those who do not do well sometimes change to chemistry, physics, mathematics, or biology. And many of them ultimately find themselves in teaching. Some of them teach for two or three years and then try to do something else if they can. Others are trapped into teaching for longer periods, but are always on the look-out for an escape.

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(17) R. Burnett, Junior Briefs, Vol. 18, No. 3, Jan.-Feb. 1955.

The answers to question 9 in the questionnaire, "Do you like teaching?" are shown in Table XV.

TABLE XV

Teachers' responses to the question, "Do you like teaching?"

	Number of Teachers	Percentage
Yes	28	80%
Somewhat	6	17.14%
No	1	2.86%
Total	35	100.0%

The answers to questions 5 and 6 in the questionnaire of teachers about the major field of study and the degree held are listed in Table XVI.

TABLE XVI

Numbers of teachers with their major field of study and degrees

Field of Study	Number of Teachers	Degrees
Chemistry	8	4 B.A.; 1 B.Sc.; 2 M.A.
Licence en Science Physiques	5	
Biology and Chemistry	4	4 B.A.
Biology	4	2 B.A.; 1 B.Sc.; 1 M.A.
Pharmacy	3	
Mechamical Engineering	2	
Psychology and Economics	1	1 B.A.
Agriculture	1	1 B.Sc.
Physics and Chemistry	1	1 B.A.
Chemistry and mathematics	1	1 B.A.
Doctorat en Physique	1	
Chemical Engineer	1	
Licence d'Enseignement des Sciences Physiques et Naturelles	1	
Medical doctor (reported orally)	1	
Junior Science	1	
Sophomore Science	3	
Baccalaureat	1	
Total	39	

Question number 8 in the questionnaire for teachers, "Did you have any teacher training courses?" shows that out of the 32 teachers who answered it, 23 or 71.88% have not taken any teacher training courses. Many of the teachers did not specialize

in chemistry. The enrollment in the secondary schools of Lebanon is usually not high enough to support full-time teachers who teach only chemistry. Most of them teach chemistry in combination with physics, mathematics, general science, or biology. The above shows that many of the present teachers did not intend to become teachers or, at least, did not prepare themselves to become teachers. This is in spite of the fact that the great majority of them reported that they liked teaching.

In answer to question number 10, "Last year were you a full time or a part time teacher?": Out of the 33 teachers who answered this question 22, or 66.66%, were full time teachers. The load of these teachers varied from a minimum of 14 periods to a maximum of 35 periods, the average being 24.33 periods per week. Some of the full time teachers have other jobs in spite of the fact that they teach full time in one school.

To see the teacher from the viewpoint of the students, it is worth considering some data presented earlier. Eight reasons were listed for students' dislike of chemistry. Of these, number 2 in importance was "Uninteresting presentation by teacher"; number 4, "Teachers not good; and, number 7, "Teachers lacking interest in the teaching of chemistry".

Of the suggestions which students were asked to give, number 3 in importance was "Better teachers"; number 4, "Well

trained teachers who understand students and know how to interest them"; number 9, "Teachers of chemistry who are specialized in chemistry".

It is unfortunate that efforts exerted by teachers towards professional growth are rare. Under present conditions, if changes of methods and techniques of teachers can take place, it will be necessary to change the teachers, themselves. Teachers try to stick to the old methods which they have learned and taught for years, and they do not really make changes, especially changes that may mean more work for them.

The chemistry courses taken by prospective chemistry teachers are specialized and are not concerned with the preparation of teachers., The few education courses taken by prospective teachers usually do not go much beyond educational and psychological theories, and classroom methods. Even a course in teacher-training for science students may fail to deal with many important problems which must be faced by the prospective chemistry teacher. Perhaps these problems are overlooked on the assumption that they will be covered in the chemistry courses.

A "trained" chemistry teacher leaves the American University of Beirut with little, if any, knowledge of the purchasing of laboratory and demonstration equipment. In schools, at present, this is mainly the responsibility of the science teacher. In many cases, for lack of judgment, the teacher does not make

the best choice and the money is not spent in a way that renders the maximum benefits. Arrangement of the laboratory, storage and care of equipment, the dangerous nature of some chemicals which are commonly used in the secondary school, the preparation of reagents, the familiarity with local and outside sources of equipment--all these are problems which the prospective chemistry teacher will have to face upon employment. One of the purposes of training a teacher is to help him to avoid the mistakes of others, and, as much as possible, to help him in facing the problems awaiting him. If the teacher is not well informed about the organization and administration of laboratories, about safe storage, dispensing, and inventory of chemicals and equipment before he starts teaching he will have to learn it in the practical teaching situation, and this can be both costly and dangerous.

No teacher can claim that his methods are perfect, and it is natural that teachers should make mistakes. But every teacher should strive to improve his methods and presentations and should exert an effort to avoid repeating mistakes. To improve, a teacher should consider critically his past experiences and the experiences of others. He should write down every idea that worked well in his teaching in order to use it in the future and to pass it on to others. He should consider the suggestions of other teachers and educationists, and try to

make use of them.

The ideal teacher is mentally alert; he is trained to think originally and clearly; and he shows an interest in young people and an understanding of their reactions and entions. He knows his subject, and his knowledge is functional. He likes teaching and is interested in it.

Science teachers cannot develop the scientific approach in their students unless they (the teachers) apply it in their own work and in their responses to questions and problems, in the classroom and outside. The successful teaching of a chemistry course requires technical training, energy, enthusiasm, and personality.

What are the problems that confront a beginning, untrained chemistry teacher in his job? These problems, once defined, should serve as a clue as to the kind of preparation and training that he should receive in teacher-training courses in order to become a trained chemistry teacher.

What are the responsibilities awaiting most chemistry teachers in the secondary schools? The main problem is that of the preparation and the organization of the laboratory. Laboratories are newly emerging in the secondary schools of Lebanon, and in most cases they are not being properly used. A new chemistry teacher is usually called upon to suggest practical ideas for the establishment of laboratory or the reorganization and the expansion of the rudiments of one.

The chemistry teacher should, therefore, be trained to assume leadership and responsibility in running the science department of his school because the science background of administrators is usually weak. The teacher should be familiarized during his training with catalogs of scientific supply companies, with sources of equipment, local and foreign, and with procedures followed in ordering apparatus. Preparation of solutions, choosing experiments for secondary school students, training in the comparison of text-books, procedures and problems of storage of chemicals, and information about safety measures are much more valuable and useful for prospective teachers than theoretical discussions. Attention of prospective teachers should be drawn to the apparatus and equipment which is available locally or which can be made by teachers themselves. Training in the care of apparatus is also of vital importance.

There are many hidden, specific, apparently simple problems that arise in the teaching of chemistry. For example, the problem of the glass cock which becomes cemented to the burette if it is not rinsed after using sodium hydroxide solution. It is suggested that some arrangement be made between the Chemistry Department and the Education Department at the American University of Beirut for the introduction of a technical course which will aim at solving as many as possible of the problems facing prospective chemistry teachers. Part of the work in this course might be spent in the store room of the

chemistry department, in the preparation of solutions, and taking part in a functioning chemistry laboratory. This course might take the place of the second semester of advanced teacher training for prospective chemistry teachers.

Practical means for developing professional growth in chemistry teachers should be devised. It is important to provide the second school chemistry teacher with opportunities for renewing his contacts with modern chemistry. A number of methods could be followed for the promotion of professional growth of teachers in-service. One way might be the establishment of an organization for chemistry teachers or for science teachers generally. Conferences, meetings, publications etc. will help chemistry teachers with their mutual problems. The exchange of ideas through the discussions which will, inevitably, follow and the presentation of successful new teaching techniques in front of the group should help to bring about professional growth. An annual meeting of science teachers in Lebanon, with exhibits and films, with lectures, discussions, and visits to the laboratories of certain schools, would be desirable.

Ratings of teachers by students, when done on an understanding and well-meaning basis, may be a very efficient instrument for professional growth. Asking students at the end of the academic year to evaluate a course through constructive criticism and suggestions for improvement has proved to the writer to be an excellent tool for self-improvement.

The strategic position that the teacher holds in the intellectual life of the students and the control that he exercises in their development are too important not to be considered in the selection of teachers. The degrees awarded, in themselves, give no complete indication of one's ability to teach a course. Many other factors both personal and professional, should be taken into consideration. The shortage of good chemistry teachers renders the job of selection more difficult. To attract better teachers, adequate inducements, especially as regards tenure and possible advancement in salaries should be offered.

A good laboratory, a good classroom, a good text-book, good visual aids and a reasonable educational system within which to work - all these are desirable in the job of helping young people to develop. But the good teacher is far more important, than these, for without him they are useless.

CHAPTER THREE

Summary and Conclusions

The present-day aim in the teaching of secondary school chemistry in Lebanon appears to be solely to prepare students for general public examinations and for higher education. The methods used in this preparation consist mainly of rote memorization. If this is accepted, then the needs of a large proportion of secondary school graduates whose formal education ends with the secondary school are not being considered in this preparation. These efforts toward preparation for examinations and higher education seem to be highly inefficient, judging from the percentage of failures in the Baccalaureat examinations and in the freshman chemistry courses of the American University of Beirut. Quoting Professor William West of the Chemistry Department of the American University of Beirut, who has long been in contact with students coming from the secondary schools of Lebanon, "It is sometimes advantageous to have the students come to the Freshman class without any preparation in chemistry". Basically, Professor West is criticizing the poor approach in the chemistry background of these students. It becomes necessary for the University to modify arbitrarily rigid study habits and patterns of thinking, which is often more difficult than building anew.

The recommended aims and objectives for the teaching of secondary school chemistry as detailed in Chapter Two are:

A. To Help Students to Understand and Appreciate the Role of Chemistry in Their Lives through:

1. Obtaining information about chemical facts, principles, and theories,
2. Understanding some of the applications of chemistry in their daily lives,
3. Recognizing the importance of chemistry in the modern world.

B. To Help Students Reason More Scientifically.

The above aims are in no way rigid or fixed; they are meant to serve as goals towards which a teacher should strive, and they should help in the formulation of a "functional" philosophy which may be translated into appropriate classroom and laboratory activity.

In practice, chemistry is not given much importance in the Baccalaureat examinations. This explains, in part, the lack of enthusiasm, or even interest, shown toward chemistry by secondary school students and teachers preparing for the Baccalaureat.

Chemistry teachers in the secondary schools of Lebanon depend on text-books to a large extent; in most cases the book at hand determines the content of the chemistry course. Teachers who do not use text-books in their teaching (mostly those preparing their students for public examinations in the English section) resort to the dictation of notes. There is, apparently, little tendency on the part of teachers or school

officials to introduce new text-books for the teaching of chemistry.

In the teaching of chemical theory, the questionnaires have shown that there is much lecturing, dictation of notes and emphasis on verbalism and memorization. Laboratory activities in most cases are merely demonstrations by the teacher. A large proportion of the students reported that their schools have laboratories, but that the teacher was the one who performed the experiments, most often in a room outside the classroom which was referred to as a laboratory in many answers to the questionnaires. Many schools are just beginning laboratory activities, and it appears that the out-moded, traditional "cook-book" method of following instructions from a laboratory manual is, by and large, being followed. There are very few who combine demonstration and laboratory work in their teaching. some guidance needs to be given to schools if their investments of money and effort in laboratory activities are to pay dividends. The utilization of audio-visual aids is very limited, due probably, to the lack of professional training of the majority of chemistry teachers.

The most obvious features of the status quo in chemistry teaching in the secondary schools of Lebanon are its verbalistic informational character, its lack of the scientific path of personal observation and experiment, and its poor methods of

of teaching. Dewey in a lecture on "Methods in Science teaching"[1], in 1916 describing the conditions of science teaching in the United States prior to World War I, said:

> "Our present methods too largely put the cart before the horse; and when we become aware of this mistake we are all too likely to cut the horse entirely from the cart and let him browse around at random in the pasture without going anywhere. What we need is to hitch the horse of concrete experience with daily occupations and surroundings to a cart loaded with specialized scientific knowledge. It is not the duty of high-school science to pack the cart full, that will come later. It is its part to make a good job of the hitching so that every pupil who comes under its influence will always find in himself a tendency to turn his crude experiences over into a more scientific form, and to translate the bare science he reads and hears back into terms of his daily life. When we do this we shall find, I am confident, the crop of scientific specialists increase, not diminish, while we shall have a citizenship of men and women really intelligent in judging the affairs of life."

This description expresses eloquently the present conditions in the teaching of chemistry in the secondary schools of Lebanon

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(1) Dewey, John as quoted by F.C. Coulson, Educational Aims in Teaching Elementary Chemistry, J. Chem. Ed., 6:1121. June 1929

and suggests a path to be followed.

The writer concludes that it is far better to treat a few topics in a manner that makes students think than to give many topics for students merely to memorize. Less factual material should be taught, but a greater understanding of chemical principles, illustrated by facts, should be emphasized. Students should be able to use intelligently the facts and principles which they know when they meet new situations. The student who upon leaving secondary school for life or for the university, can reason scientifically, has a great advantage over the student who knows many facts but does not know how to apply them. The success of a chemistry course should not be evaluated by the quantity of information the instructor imparts or by the number of pages he "covers". The curiosity he arouses and the imagination, thinking, and interest which he awakens are far better criteria.

The secondary schools prepare their students for universities by giving them as much as possible of the material taught in universities, thus leading to much repetition. They do not realize that it is the quality of the teaching that needs to be changed, and not the quantity.

The indirect control by public examinations and university entrance requirements on secondary school chemistry teaching, the lack of vital relationships between chemistry instruction

and every-day life, and the uninteresting presentation of chemical subject matter--all these should be recognized in any attempt to improve chemistry teaching. School owners, principals, and chemistry teachers have to change their prevailing philosophy before they can change anything else. They need a philosophy that calls for the abandonment of memorization of subject matter and facts as being the main objectives of chemistry teaching. Their philosophy should guide them toward teaching chemistry as a means for the development of good habits, creative attitudes, and constructive thinking.

It is hoped that the problems which have been discussed in this study will provoke thought, and that further research will be undertaken in those areas where it has been shown that information is incomplete or lacking.

A Suggested Approach For The Application of The Suggestions Given in The Thesis to The Actual Situation in Lebanon

Many administrators and teachers try to adhere to the methods and procedures under which they have studied and worked for years. Reading about new ideas and suggestions is not, by itself, any guarantee that they will even consider these suggestions. Many of them ask for evidence and proof that the suggested change is better than the practiced procedure. Unfortunately, it is not possible to provide such evidence for every suggestion. In the past many countries approached the teaching of chemistry as is now done in Lebanon. Educators in those countries called for change after becoming aware of the ineffectiveness of their teaching of science. Later reports and studies about the changes that have taken place have shown that the change was in most cases for the better. There is much similarity between our present situation in the teaching of chemistry and situations in the past of other countries. The outcomes of the teaching of chemistry in the secondary schools of Lebanon, at present are so deplorable that almost any change in methods would be an improvement. The following are a few suggestions for an approach for the application of the suggestions:

1) Responsible individuals in the Ministry of National Education and Fine Arts should be familiarized with this study and the suggestions it contains. The disagreements that may arise should be discussed, and further evidence should be brought forward to support the points of view presented in the study. If these

responsible officials do not agree on some of the points for lack of evidence, they should at least be ready to experiment with some of the new ideas and then to judge them on the basis of their workability.

2) An important key for the solution of the problem is in the examination. The chemistry examination in the Baccalaureat should be given more importance and should be modified so as to depend more heavily on understanding and scientific reasoning. Once such a change is implemented, the methods of teaching chemistry will automatically change to comply with the examination requirements.

3) A committee of educators and chemistry teachers should be formed to study new text-books and to make recommendations regarding them to schools. The committee could also study other problems that may arise in the actual teaching of chemistry and suggest solutions for them. Such a committee may be subsidized by the Ministry of Education or by a separate agency.

4) Writers should be encouraged to write chemistry text-books that are intended for students in this part of the world. Examples relating chemistry to daily-life which appeal to secondary school students of this area should be collected to enrich such books. The questions and problems included in the text-books should reflect the suggested philosophy of understanding as opposed to memorization. The questions should be thought-provoking; any one problem should not involve many principles nor should it be arithmetically difficult.

5) Professional growth of teachers in service should be promoted. Lectures, conferences, and pamphlets explaining the history of chemistry teaching and laboratory work, the pitfalls which should be avoided, and the relative values of the different methods and procedures will help teachers in service to improve themselves professionally.

6) The quality of the teacher training courses for prospective chemistry and science teachers should be improved and should try to solve problems of practical value. Preparation of teachers for general science courses is lacking and should be provided. More people should be encouraged through scholarships to prepare themselves for science teaching. As the number of applicants increases, selection may be on a competitive basis, thus improving the quality of teaching.

7) Films and filmstrip libraries should be started as suggested on page 96.

8) An expert in the construction and the organization of secondary school laboratories should be supplied through the cooperation of the Government and the U.S.O.M. (Point IV). This will be of great help especially at this early stage of growth in secondary school laboratories. This expert will act as an advisor to schools on how to build, organize, and administer the newly emerging laboratories.

The Limitations of the Present Study with Suggestions for Further Research

The suggestions and recommendations made in this study a re based on the treatment of similar problems in the teaching of chemistry in other countries, on the viewpoints of other teachers and professors who were consulted, and on the writer's own teaching experience. No definite measurement has been attempted in this work to demonstrate that the suggested solutions and recommendations for some of the problems are superior to current practices.

Interpretations of questionnaire responses were based on the assumption that these questionnaires were answered truthfully. However, a study of two questionnaires of students from the same school, who graduated the same year, reveals differing answers to some of the questions. For example, answers of a large proportion of the students to questions about laboratory activities were shown to be rather unreliable by answers to other questions in the same paper which revealed the many different interpretations of the term, "laboratory" in the minds of those who were queried. More representation in the questionnaires for graduates of secondary schools who did not proceed to higher education would have improved the study. The sampling was perhaps seriously biased by the fact that a large proportion of teachers did not answer the questionnaires.

The suggested program of studies in science presented on page 34 was worked out with the idea that its incorporation in the present program would be easy. It is based on the old program in a number of aspects. What is needed is a review of the whole program as a unit--a review which is beyond the scope of the study in hand. More specific description of what should actually be taught, the content of the course, and the sequence of topics is needed. A detailed description of the syllabus which will be a compromise between the requirements of the college-preparatory and the terminal pupils is a real need.

Some statements in the study may appear to be self-evident, but were not supported by evidence. Further research may help to determine their validity. Some of these statements are:

1) A purpose of chemistry teaching should not be the memorization of many facts about the elements.

2) Memorization and recitation of laws, theories, and facts in themselves are far from being a guarantee that students will be able to use this memorized material for practical purposes.

3) Facts and details which are memorized in any course of study are retained for but a short time after the completion of the course.

4) Efforts exerted by teachers towards professional growth are rare.

5) Most of the students have their first and final formal contact with chemistry in the secondary school.

6) Most secondary school students will not proceed to higher education.

Further research may reveal the language, native or foreign, which will do the better job of teaching chemistry at the secondary level. Besides, it is hoped that further research will justify some of the broad generalizations made in the thesis such as:

1) The teacher should not emphasize theoretical values in the results of laboratory experiences. He should stress objectivity and honesty in reporting.

2) Whether or not the students arrive at correct answers should be of minor importance in the secondary school laboratory.

3) In a subject like chemistry, the less a student knows about it, the more direct observation he needs.

Although these statements were not substantiated by research, they seem to offer reasonable procedures to follow.

Inclusion of the following topics could have strengthened the study:

1) More visits to schools and to classrooms in which chemistry is being taught. It should be kept in mind that adequate physical facilities in classrooms and laboratories do not by themselves tell much about the use to which they are put.

2) Suggestion of a compromise between the suggested methods and philosophy of teaching and the current ones, if there is to be no concomitant approach to change the examination system.

3) Details of a chemistry syllabus which would take care of students on both extremes of ability as well as those in the central group.

4) The collection and presentation of more chemical items and topics related to every-day life.

5) A list of experiments and laboratory activities to be included in the secondary school laboratory.

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APPENDIX A

The Questionnaires Used in the Study

Anglo-Saxon Schools

This Questionnaire is part of a research on the "Teaching of Chemistry in the Secondary Schools of Lebanon". The purpose is a better understanding of the present status of the teaching of chemistry, its difficulties and problems, with a view to provide suggestions for its future improvement, The general results of the investigation will constitute part of an M.A. thesis on the mentioned topic which I hope will be of use to all concerned.

Your cooperation would be greatly appreciated.

DIRECTIONS:

Please write the answers in the space provided right after the question. If you need more space you can make use of the back of the sheets. Do not answer a question if you are not sure of its answer. Place a check mark inside the parenthesis following the right answer, e.g. yes (✓), if the answer is yes; and a check in the space provided after "no" if the answer is no, etc....

I. Questionnaire of Students of Anglo-Saxon Schools

1. Name the Secondary School you have attended last:

_____

2. How many years did you spend in that school at the secondary level? _____ years.

3. Date of graduation from secondary school _____.

4. How many students were in your last secondary school class (One division) _____ students.

5. How many years of chemistry did you study in that school? _____ Years.

6. Number of periods of chemistry that were given per week in each year.

	1st. year of chemistry	2nd year of chemistry
Laboratory:	_____Periods	_____Periods
Regular Class:	_____Periods	_____Periods
	3rd. year of chemistry	4th year of chemistry
Laboratory:	_____Periods	_____Periods
Regular Class:	_____Periods	_____Periods

7. Name of textbook used _____.

8. Was there a chemistry Laboratory in that school? Yes ( ) or No ( ).

9. How would you rate that laboratory? Excellent( ), Good ( ), Fair ( ), Poor ( ).

10. Did you have regular periods every week for chemistry laboratory work? Yes ( ), No ( ).

11. Did you work in the chemistry laboratory individually ( ), by pairs ( ), or _____?

12. How could that laboratory have been improved?

_____

_____

13. How many different teachers of the chemistry taught you in that school? _____ teachers.

14. Did you like chemistry as it was taught in the secondary school? Yes ( ), No ( ). Why? _____

_____

_____

15. Did the teacher use films ( ), charts ( ), graphs ( ) in his teaching?

16. Did the teacher use to point out to the class new discoveries in chemistry, like now elements discovered etc.? Yes ( ), No ( ).

17. Was the method of the chemistry teacher in solving problems different from that of the mathematics teacher? Yes ( ), No ( ).

18. How often did you have experimental demonstrations given by the teacher in the chemistry class? Very often ( ), Often ( ), An average of once per week ( ), Very rarely ( ), Never ( ).

19. How often did the student take part in class demonstrations? Very often ( ), Often ( ), Occasionally ( ), Very rarely ( ), Never ( ).

20. Did you perform experiments by following instructions from the laboratory book word by word? Yes ( ), sometimes ( ), No ( ).

21. Did your teacher lecture much in class? Yes ( ), No ( ).

22. Did he conduct the class most of the time by questions and answers? Yes ( ), No ( ).

23. Relatively, howmuch time was spent by your teacher in dictating notes? Very much ( ), Much ( ), Some ( ), Very little ( ).

24. Were students allowed to ask questions? Always ( ), Sometimes ( ), Never ( ).

25. Were students encouraged to ask questions? Yes ( ), No ( ).

26. How often did you have difficulty in doing the assignment and homework? Very often ( ), Often ( ), Occasioanlly ( ), Very rarely ( ), Never ( ).

27. Did your teacher stress memorization ( ), Understanding ( ), or both ( ).

28. Were the efforts of the teachers directed towards having you pass a certain examination? Yes ( ), No ( ).
If yes, what examination? _____

29. How long did it usually take the teacher to give back the daily tests corrected? More than one week ( ), One week ( ), More than 3 days ( ), More than one day ( )? One day ( ).

30. Did the teacher explain the test and/or the examination? Yes ( ), Sometimes ( ), No ( ).

31. Was the Chemistry laboratory interesting? Yes ( ), Somewhat ( ), No ( ).

32. Do you believe that the course of chemistry as it was given in your secondary school has been useful for these students who did not continue their studies and why?

_____

_____

_____

_____

Write on the back of the sheet suggestions for the improvement of the teaching of chemistry as you see them. Do not pay much attention to language.

II. Questionnaire of Teachers of Anglo-Saxon Schools

1. Name the Secondary School in which you were teaching last.

_____

2. For how many years does a student study chemistry in that School? _____ year (s)

3. Number of periods of chemistry that are given per week in each year:

	1st. year of chemistry	2nd. year of chemistry
Laboratory:	_____Periods	_____Periods
Regular Class:	_____Periods	_____Periods

	3rd. year of chemistry	4th. year of chemistry
Laboratory:	_____Periods	_____Periods
Regular Class:	_____Periods	_____Periods

4. Are the periods of laboratory assigned in the schedule ( ) or is it left to the teacher's own arrangement to take students to the laboratory ( )?

5. What was your major field of study?_____

_____

6. What is the highest class you have completed:_____

_____

7. Do you believe it is necessary for a high school teacher in chemistry to have a B.S. in chemistry: Yes ( ), No ( ). Explain your point of view. _____

_____

_____

8. Did you have any teacher training courses? Yes ( ), No. ( ). If yes, specify._____

_____

9. Do you like teaching? Yes ( ), Somewhat ( ), No ( ). Why? _____

_____

10. Last year, were you a full time ( ), or a part time ( ) teacher?

11. How many periods in all did you teach per week? _____Periods.

12. Did you meet difficulty in teaching problems of chemistry because the mathematics background of the students was not adequate? yes ( ), Sometimes ( ), No. ( ).

13. In general, did your students like chemistry? yes ( ), Somewhat ( ), No. ( ).

14. How often do you perform demonstrations of chemistry in class? very often ( ), often ( ), an average of once a week ( ), very rarely ( ), Never ( ).

15. In general, do the students prepare satisfactorily their daily work when they do not expect to have a test? _____

_____

16. In general, do the students perform the experiments in the laboratory out of interest ( ), or they try to perform a duty( )?

17. Do you have the following materials in your school?- A movie projector ( ), a filmstrip projector ( ), chart of the periodic table ( ), demonstration table in the classroom ( ).

18. Are the students graded for their laboratory work? yes ( ), No. ( ). If yes, about how much per cent? _____%

19. How can the laboratory be improved? _____

_____

_____

20. Were your efforts directed towards having the students pass a certain exam. yes ( ), No. ( ). If yes, what Exam? _____

21. What important problems did you meet in teaching chemistry?

_____

_____

22. Is chemistry considered by the school more important ( ), equally important ( ), or less important ( ), than physics and why? _____

_____

23. Do you find difficulty in meeting the different needs and interests of the students? yes ( ), Sometimes ( ), No. ( ).

24. Do you believe that the chemistry course that is given in your school is useful to those students who do not go to Universities and why? _____

_____

_____

25. Do you believe that all secondary school students must study chemistry? Yes ( ), No. ( ). Defend your position. _____

_____

_____

26. What are your aims and objectives in the teaching of chemistry?

_____

_____

_____

Schools Following the French System

Ce questionnaire fait partie d'une recherche sur "l'Enseignment de la Chimie dans les écoles Secondaires du Liban". Il a pour but une meilleure comprehension de l'etat actuel de l'enseignement de la Chimie, ses problèmes et ses difficultés, en vue de fournir des suggestions pour une amélioration future. Les résultats genéraux de cette recherche constitueront une partie d'un thèse de M.A. sur le thème déjà cité, qui, j'espère, sera de quelque utilité aux intéressés.

Votre coopération scrait hautement appréciée.

Renseignements:

Veuillez écrire les réponses dans les espaces laissés justeapres les questions. Si vous avez besoin de plus d'espace, continuez au verso des feuilles. Ne répondez pas aux questions si vous n'êtes pas sur de la réponse. Marquez un signe entre les parentheses suivant la réponse exacte; example, oui ( ) si la réponse est affirmative et un signe dans l'espace laissé après de "non" si la réponse est negative.

III. Questionnaires of Students of Schools of the French System

1. Nommez l'école secondaire où vous avez poursuivi nos études

---

2,3. Date d'entrée ( ) et de sortie ( ).

4. Combien d'élèves y-avait-t-il en moyenne par classe dans cette école? Moins que vingt ( ), entre vingt et trente( ), entre trente et quarante ( ), plus de Quarante ( ).

5. Nombre d'années pendant lesquelles vous avez étudie la Chimie dans cette école. _____

6. Combien d'heures de Chimie donne-t-on par semaine au cours de chaque annee?

ANNEE DE CHIMIE	CLASSE REGULIÈRE HEURES	LABORATOIRE HEURES
1ere. Année de Chimie	_____	_____
2eme Année de Chimie	_____	_____
3eme Année de Chimie	_____	_____
4eme Année de Chimie	_____	_____
5eme Année de Chimie	_____	_____
6eme Année de Chimie	_____	_____
7eme Année de Chimie	_____	_____

8. Cette école possédait-elle un laboratoire de Chimie? Oui ( ), Non ( ).

9. Ce laboratoire etait-il excellent ( ), bon ( ), passable ( ), Pauvre ( )?

10. Aviez vous des heures régulières consacrees aux expériences ä laboratoire? Oui ( ), Non ( ).

11. Vous y travaillez au laboratoire individuellement ( ), deux par deux ( ), ou _____?

12. Comment peut-on améliorer le laboratoire? _____

_____

13. Nombre de professeurs qui vous ont enseigné la Chimie à l'école secondaire. _____

14. Avez vous aimé la chimie telle qu'elle vous a été presentée à l'école? Oui ( ), Non ( ). Pourquoi? _____

_____

15. Votre professeur se servait-il de films ( ), de cartes ( ).

16. Vous a-t-il parlé des découvertes récentes en Chimie? Oui ( ), Non ( ).

18. Combien de fois faites-vous des expériences de Chimie durant la classe regulière? Tres souvent ( ), souvent ( ), une fois par semaine ( ), rarement ( ), jamais ( ).

19. Avez-vous fait des expériences en suivant littéralement les instructions du livre de laboratoire? Oui ( ), Parfois ( ), Non ( ).

21. Est-ce que votre professeur a fait de nombreuses conférences en classe? Oui ( ), Non ( ).

22. A-t-il adapté la plupart du temps en classe la méthode des questions et des réponses? Oui ( ), Non ( ).

23. Combien de temps le professeur passait-il en moyenne a dicter son cours? tout le temps ( ), beaucoup de temps( ) pas beaucoup de temps ( ), un peu de temps ( ).

24. A-t-on permis aux étudiants de poser des questions? toujours ( ), parfois ( ), jamais ( ).

25. Est-ce que le professeur encouragait les questions? Oui ( ), Non ( ).

27. Le professeur insistait-il par ses questions sur le travail en memoire? ( ), ou celui de comprehension ( ), ou tous les deux ( ).

28. Les efforts de professeur tendaient-ils a faire passer un certain examen? Oui ( ), Non ( ), si oui quel examen

_____

29. Au bout de combien de temps à peu près vous rendait-on les récitations écrites? plus d'une semaine ( ), une semaine ( ), plus de trois jours ( ), plus d'un jour ( ) un jour ( ).

30. Le professeur expliquait-il ces récitations écrites? Oui ( ), quelquefois ( ), jamais ( ).

31. Est-ce que le travail de la Chimie en laboratoire etait interessant? Oui ( ), pas beaucoup ( ) pas du tout ( )

32. Creyez-vous que le cours de Chimie tel qu'il vous été presenté dans cette ecole secondaire a été utile a ceux qui n'ont pas poursuivi leur études? Oui ( ), Non ( ). Pourquoi? _____

_____

Priere décrire au verse des feuilles les suggestions possibles relatives a l'enseignement de la Chimie.

IV. Questionnaire of Teachers of Schools of the French System

1. Dans quelle ecole secondaire enseignez-vous?

_____

2. Pour combien d'années est-ce-qu'un élève étudie la Chimie dans votre école? _____

3. Combien d'heures de Chimie donne-t-on par semaine au cours de chaque année?

ANNEE DE CHIMIE	CLASS REGULIERE HEURES	LABORATOIRE HEURES
1ère année de Chimie		
2ème année de Chimie		
3ème année de Chimie		
4ème année de Chimie		
5ème année de Chimie		
6ème année de Chimie		
7ème année de Chimie		

4. Est-ce que les heures de laboratoire sont inscrites dans le programme ( ) ou est-ce que le professeur arrange ses heures ( )?

5. Quelle est votre specialité? _____

6. Quel diplôme avez-vous obtenu? _____

8. Avez-vous suivi des cours de pedagogie? Oui ( ), Non ( ). Si "oui" spécifiez _____

_____

9. Aimez-vous l'enseignement? Oui ( ), un peu ( ), Non ( ), Pourquoi? _____

_____

10. Enseignez-vous toute la journée ( ), ou une partie seulement ( ),

11. Combien d'heures enseignez-vous par semaine? _____

12. Est-ce que dans l'ensemble ves élèves ont aime la Chimie? Oui ( ), un peu ( ), Non ( ).

14. Combien de fois faites-vous des expériences de Chimie durant la classe regulière? très souvent ( ), souvent ( ), une fois par semaine ( ), rarement ( ), jamais ( ).

15. Est-ce aue dans l'ensemble les élèves accomplissent leur devoir quotidien d'une facon satisfaisante même quand ils ne s'attendent pas a un examen? _____

_____

16. Est-ce aue les élèves font en général les expériences par intérét ( ) ou par devoir ( )?

17. Avez-vous l'equipement suivant dans votre ecole?
Un projecteur cinématographique ( )
Une carte de la table périodique ( )
Une table d'expériences en classe regulière ( )

18. y a t-il des notes pour les travaus de laboratoire? Oui ( ), Non ( ). Si oui, quel en est le pourcentage approximatif?

19. Comment peut-on améliorer le laboratoire? _____

_____

20. Presentez-vous vos efforts en vue de faire réussir vos élèves a un examen quelconque? Oui ( ), Non ( ), Si oui, lequel

_____

_____

21. Quels problèmes importants rencontrez-vous en enseignement la Chimie? _____

_____

22. Dans votre école considère-t-on la Chimie plus importante ( ), aussi importante ( ), moins importante ( ), que la physique? Pourquoi? _____

_____

23. Trouvez-vous de la difficulté à circonvenir aux interests et besoins de vos élèves? Oui ( ), parfois ( ), Non ( ).

24. Creyez-vous que le cours de Chimie enseigné dans votre ecole est utile a ceux qui ne vont pas aux universités et pourquoi? _____

_____

25. Pensez-vous que tous les élèves des ecoles secondaires etudier la Chimie? Oui ( ), Non ( ), Expliquez votre point de vue _____

_____

26. Quels sont vos buts et vos objectifs dans l'enseignement de la Chimie? _____

_____

APPENDIX B

Number of Candidates for the Government Examinations, the Brevet, and Baccalaureat Part I and II, for the years 1951-55, Giving the Number and Percentage of Those who passed

The Brevet

Year	No. of candidates	No. Passed	Per cent Passed
1951	1608	479	29.7
1952	2215	654	29.5
1953	3327	520	15.6
1954	3009	1181	39.2
1955	3501	1035	29.5

Baccalaureat Part I

	Literary			Scientific		
Year	No. of candidates	No. Passed	PerCent Passed	No. of candidates	No. Passed	Per cent Passed
1951	777	234	30.1	1043	487	46.6
1952	978	230	23.5	1122	514	45.8
1953	1316	96	7.2	1645	269	16.3
1954	1601	245	15.3	1757	212	12
1955	862	216	25	1754	418	23

Baccalaureat Part II

Year	No. of Candidates	No. Passed	Per cent Passed	No. of Candidates	No. Passed	Per cent Passed
1951	185	50	27	664	232	34.9
1952	270	107	39.6	915	437	47.7
1953	354	82	23.1	1026	167	16.2
1954	287	83	28.9	678	145	21.3
1955	325	43	13.2	715	141	19.7

APPENDIX C

Baccalaureat Certificate Examination- Part II- Philosophy Section The Second cycle of the Year 1956

Examination in Science — Time: 3 hours

The following is from the original French paper:

Sciences physiques et chimiques

Traiter au choix l'une des trois questions suivantes:

I - Reflexion des ondes; ondes stationnaires; examples Accounstiques.

II - Propriétés physiques et chimiques du benzène. On tiendra compte des formules developpées dans les différentes réactions.

III- Répondre aux quatre questions suivantes:

a. Préparation du méthane.

b. Réactions d'addition que donne l'éthylène.

c. Oxydation de l'alcool éthylique.

d. Préparation de l'éther ordinaire (oxyde d'éthyle).

Sciences Naturelles

Traiter au choix l'une des trois questions suivantes:

I - Caractères morphologiques et physiologiques de la cellule animale.

II - Après avoir dessiné 2 schémas donnant une idée assez precise et complète de la structure du coeur, expliquez, avec soin, son fonctionnement.

III- Après avoir défini les termes suivants: receptivité immunité, vaccination et sérothérapie, exposez le mécanisme et les méthods de la vaccination. Donnez des exemples a l'appui.

The writer's translation of the above-mentioned examination:

Physical and chemical sciences

Choose one of the three following questions:

I - Reflection of waves; stationary waves; acoustical examples.

II - Physical and chemical properties of benzene. The formulas developed in the different reactions will be taken into consideration.

III- Answer the following four questions:

a. Preparation of methane.

b. Addition reactions which give ethylene

c. Oxidation of ethyl alcohol.

d. Preparation of ordinary ether.

Natural Sciences

Answer one of the three following questions:

I - The morphological and physiological characters of the animal cell.

II - After drawing two diagrams giving a sufficiently precise and complete idea about the structure of the heart, explain, carefully, its function.

III- After defining the following terms: receptivity, immunity, vaccination and Serotherapeutics, expose the mechanism and the methods of vaccination. Give supporting examples.

APPENDIX D

Number of Responses to the Questionnaires for Students and Teachers giving the Names of Schools Represented

I. Questionnaire of Students in Anglo-Saxon Schools

	Name of School	Number Represented
1.	A.G.B.U.S.S.B. (Armenian Secondary School for Boys)	6
2.	A.G.B.U.S.S.B. (Armenian Secondary School for Girls)	1
3.	Al-Ahliyyeh College for Girls	2
4.	American Community School	1
5.	American School for Girls	5
6.	Armenian Evangelical College	6
7.	Armenian Evangelical Central High School	1
8.	British Lebanese Training College for Girls	4
9.	Brummana High School	6
10.	English School for Boys	9
11.	Evangelical National School for Girls	4
12.	Gerard Institute, Sidon	4
13.	High School of Life Armenian)	1
14.	Lebanon College of Suk-el-Gharb	5
15.	Middle East College	1
16.	Marja'youn National College	1
17.	National College, Shweifat	2
18.	National Protestant College, Beirut	4
19.	Preparatory Section of the International College	13
20.	School of Good Sheperd, Ashrafiyyeh	1
21.	Sidon Girls' School, Sidon	1
22.	Shweir Secondary School	2
23.	Tripoli Boys' School	5
24.	Tripoli Girls School	3
25.	Tripoli College	3
26.	Universal College of Aley	3
27.	X (Schools Not Named)	2
	Total	96

II. Questionnaire of Students in Schools of the French System

	Name of School	Number Represented
1.	Amilieh College, Beirut	2
2.	College des Freres, Beirut	1
3.	College des Freres, Tripoli	1
4.	College de la Salle, Section Secondaire	1
5.	College de la Sagesse	1
6.	College de Sacre Coeur	1
7.	College de Makaced, Beirut	2
8.	College de Makaced, Sidon	1
9.	College du Notre Dame du Jamhour	1
10.	College Francais de Sacre Coeur (Freres)	2
11.	College Nationale Orthodoxe, Tripoli, Mina	1
12.	College Patriarchal	3
13.	College Protestant Francais du Beirut	1
14.	College St. Elie Bittina, Beirut	1
15.	College Secondaire of St. Joseph University	3
16.	College St. Vincent de Paul	1
17.	College Victoria, Baabda	1
18.	Centre d'Etudes	1
19.	Couvent Charfeh-Harissah-Daroun	1
20.	Ecole Officielle du Nabatieh (Gouvernement)	1
21.	Institue St. Anne des Soeurs de Besancon	1
22.	L'Institution St. Paul	1
23.	Lycees Francais du Beyrouth	3
24.	Section Secondaire of the International College	9
	Total	41

III. Questionnaire of Teachers in Anglo-Saxon Schools

	Name of School	Number Represented
1.	A.G.B.U. Tarouhi Hagopian School for Girls	1
2.	Al-Ahliyyah College for Girls	1
3.	Al-Tafawwoq School for Girls, Sidon	1
4.	Al-Ikhaa' School, Beirut	1
5.	Armenian Evangelical College	2
6.	Anglican Bishop School, Ain-Anoub	1
7.	Ashrafiyyeh High School	1
8.	British Lebanese Training College	1
9.	Brummana High School	1
10.	Evangelical Junior High School	1
11.	First School in Shweifat	1
12.	Gerard Institute, Sidon	1
13.	Preparatory Section of the International College	2
14.	Shweir Secondary School	1
15.	Sidon Girls' School, Sidon	1
16.	The National College, Shweifat	1
17.	The Lebanon College of Suk-el-Gharb	2
18.	Makassid School for Boys, Ashrafiyyeh	1
19.	Tripoli Boys' School	1
20.	Tripoli College	1
21.	Tripoli Girls' School	1
	Total	24

IV. Questionnaire of Teachers in Schools of the French System

	Name of School	Number Represented
1.	College Makaced des Garcons, Saida	1
2.	College Makaced des Filles, Saida	1
3.	College de l'Annonciation	1
4.	College Makaced des Filles, Beirut	1
5.	College Notre Dame de Jamhour	2
6.	College St. Elie Bittina	1
7.	Ecole Marguerite Marie	1
8.	Section Secondaire, International College	1
9.	Seminaire St. Maron, Ghazir	1
10.	College St. Ephram, Zahle	1
11.	Institution St. Paul	1
12.	Nechan Palandjian Djemaran (Armenian College)	1
13.	L'Ecole Secondaire Officielle et L'Ecole Nationale Kourannite a Amyoun	1
14.	X (Name of School not Included	1
15.	X " " " " "	1
16.	X " " " " ", Tripoli	1
	Total	17

APPENDIX E

A Quotation from a notice from the Registrar's Office of the American University of Beirut dated June I3, I957.

"According to regulations of the Lebanese Government, all Lebanese students who wish to study medicine, dentistry, pharmacy or law are required to have the Lebanese Baccalaureat, Part II, or its equivalent. For engineering, the Lebanese Baccalaureat, Pa rt II, or its equivalent will not be required from Lebanese students who start engineering in October I957, but will be required after October I957.

The Sophomore Diploma of this University was recognized as equivalent to the Lebanese Baccalaureat, Part II, for students who received the Sophomore diploma in October I956 or before. A new decree No. I6054, dated June I, I957, was issued which extended the recognition of the Sophomore Diploma for an additional year. According to this decree, the following will benefit from this extention of the equivalence of the Sophomore Diploma to the Lebanese Baccalaureat, Part II : -

I. All those who qualify for the Sophomore Diploma in October I957 or before.

2. All students who were admitted to the Freshman or Sophomore classes of this University before the academic year I956-57 a nd who receive the Sophomore Diploma not later than October I 959."