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**"A CRITICAL STUDY OF SCIENCE TEACHING IN SYRIAN
PUBLIC SECONDARY SCHOOLS - AND EVALUATION
OF CONTENT AND METHOD IN THE LIGHT
OF MODERN THEORY AND PRACTICE**

by

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Preface

No doubt that our age can be fairly called the age of science. Through science modern man is discovering and controlling many secrets of nature. The industrial revolution and the wonderful transformation of production and distribution are "the fruit of experimental science". As a matter of fact, experimental science is the main factor in this modern and rapid material progress. Contemplation and mere logical reasoning are no more accepted as sole effective means to scientific advance. Actually, the history of science and its modern achievements show us that the ages in which scientific progress was slow, were the ages when men developed their knowledge by logical reasoning and contemplation. In the seventeenth century and the succeeding centuries, when experimental studies in science emerged, or when the Galilean and not the old Aristotelean method was used, the development of science was rapid resulting in scientific discoveries and inventions. Thus the scientific method has become the high-road to knowledge of nature and her ways. This is the justification for experimentation and laboratory work which modern educators advocate in science teaching today as the reader will see when he proceeds further in reading this thesis.

Perhaps one of the major contributions of science is that

it has broken the physical barriers which used to separate men of different lands. Actually, science has brought about interdependence and wider intercourse among nations. One can say truthfully that the world is becoming smaller and smaller. The writer, consequently shares the conviction with those who believe in the positive and constructive role of science, in its capability to correct abnormalities, injustices and other social deficiencies. Thus, science has made us look at the future with confidence and hope, instead of looking backward to the "Golden Age" in remote antiquity. It is in this connection that Dewey says that science gives us "a firm belief that intelligence properly used can do away with evils once thought inevitable. To subjugate devastating disease is no longer a dream; the hope of abolishing poverty is not utopian. Science has familiarized men with the idea of development, taking effect practically in persistent gradual amelioration of the estate of our common humanity". (1)

It is in the light of scientific progress, that we have tried to study critically the teaching of science in our Syrian secondary schools. "The problem of an educational use of science", says Dewey, is then to create an intelligence pregnant with belief in the possibility of the direction

(1) John Dewey "Democracy and Education", The MacMillian Co., New York, 1950, 23rd printing 1950, -, 263.

of human affairs by itself" (1), and not by some metaphysical power. This is closely related to what is called "The scientific spirit", which we should develop in the students of this part of the world.

The main questions that we have to answer here are the following:-

Does science as it is used and taught in our schools make for the development of this "scientific spirit"? Is science, as it is prescribed in our curriculum and as it is transmitted to our students through the methods in use, doing anything to minimize the superstitions and illusions under which we live? What are the weak points in the make-up of our science teaching? How can we overcome the difficulties which stand in the way of making the teaching of science in order to obtain a wholesome scientific attitude in dealing with every day problems? These and many other problems constitute the object of this thesis which is divided into five chapters dealing with:-

- 1- Background of science teaching in Syria.
- 2- The present situation of science teaching.
- 3- An experimental study for the evaluation of students' achievement in Syria.
- 4- Better ways of teaching science in Syria.
- 5- Suggestions and recommendations for the improvement of science teaching in Syria.

(1) Op. Cit. p, 263.

It is the writer's hope that this critical study will prove useful in showing some of the shortcomings in science teaching in this part of the world and ways of correcting them. It is hoped also that this study will initiate further studies which may lead to real and genuine reform in all our educational, social and economic life.

I wish to express here my deep thanks and acknowledgment to the Department of Chemistry, Education and Psychology at the American University of Beirut and to all those who helped through suggestions, criticisms and other ways, to make this thesis see the light.

Z.F. Ibrahim Pasha

Beirut, August 1951.

Chapter I
**Background of Science Teaching
in Syria.**

The intelligent investigator who examines closely and objectively the actual teaching of science in Syrian schools will discover that science teaching is still in its infancy. And even though the teaching of science does not go back to more than fifty years, yet it suffers a lot from certain obsolete ideas which it carries in its folds.

I - Science Teaching in Syria Before the War 1914-1918:-

Before the first world war Syria was a province of the Ottoman Empire. Consequently education in Syria was controlled and determined by Constantinople. Until the end of the 18th and in the early part of the 19th century there were the following kinds of schools:-

1- Elementary schools, known as (Maktab)

2- The theological seminaries, known as (Madrassah). They were simple schools provided usually by charitable persons or pious foundations (1) and attached to Mosques.

Teachers in these schools were clergymen (Sheikhs). They employed the traditional methods based on discipline and memory work. In the (Maktab) the three "r's" plus memorizing certain parts of the Kor'an ^{with *undutaku* *Latin*} Turkish was the language taught.

(1) Babikian, his unpublished work called "Civilization and Education in Syria and Lebanon" 1938, p.80 in the A.U.B. Library.

No science was given. In the theological seminaries the subjects taught were: Arabic, grammar and syntax, rhetoric, style, logic, theology, metaphysics and other studies related to the Kor'an and Islamic tradition (1). This was the education prevailing in Syria till the first half of the 19th century when Syria began to feel the influence of western civilization which came to it by way of Turkey, Egypt and Lebanon. At this time the Turkish reform began to have its repercussions felt on Syria. Some pioneer thinkers perceived the necessity of changing the prevailing kinds of schools.

In order to make them fit in with the needs of the times. Their efforts to change the system of schools and to modify the curriculum failed because of the great conservatism and religious resistance of the syrian people. That was why they left those schools as they were and opened new ones in which new subjects were taught. The main factors which motivated these changes and led ultimately to the development of the new schools were primarily military secondarily social emanating from the desire of the Ottoman Government to strengthen and modernize its army. That was why most of the schools which were later on established were military schools. As these schools were concerned with the modern art of war, mathematics and the sciences were an insistent^e necessity. Consequently these subjects were introduced in the military schools at first. Later on however science and mathematics were taught and other

(1) Ibid p. 80 - For more details, see M.Ihsan Bey "The Year book of Education 1932. Evan Brother Limited Montagne house, Russell Sq- London W.C. 1931, pp. 970 on.

kinds of pre-military schools were opened. This happened because the military schools required more time and higher technical subjects to train the future officers. The latest pre-military schools were called (Military Hushdiyeh) and their aim was to prepare students for the higher military schools. Still another kind of school was established under the name of "Idadiyeh" or preparatory school which was designed to prepare Government officers and for the professions, these two kinds of schools were found in every (Wilayah) in Syria, and science was one of the subjects taught in them. This was a decisive step toward the introduction of science education although it was not until 1908 or 1910 that science could find its right place in both elementary and secondary schools when the newly reformed program was introduced. Commenting on this M. Ihsan Bey, said "the program of 1910 extended the period of compulsory attendance to six years, inefficient schools were closed, nature study, object lessons, handwork, drawing, music and physical training were added to curriculum, and the courses in history and geography were broadened. Arabic and Persian which dominated the old program were eliminated. The study of the Kor'an and of religion however, still held an important place" (1). The object lessons were most

(1) M. Ihsan Bey in "The Year Book of Education" 1932, Editor in chief Lord Enstace Percy. Evan Brother Limited Montagne house, Russell S.Q. London, W.C. 1931, pp. 972-973.

probably imitations of the French "Leçon de Choses" which have persisted until the present in Syrian elementary schools.

From this brief historical survey one can conclude that science teaching has been only recently introduced to Syrian schools, almost at the end of the 19th century the aim was primarily preparation for military training; on the higher level the content was military engineering with simple notions of mathematic and physics, the methods of teaching were authoritative.

II - Science Teaching In Syria After the War of 1914-1918:-

After the war Syria was occupied first by the Arab revolutionary army for few months, later by the Shariffian army. At that time the majority of the Ottoman school teachers and the government employees left Syria. The Arab teachers who remained had a turkish educational background; they consequently could not teach in arabic. The texts were also wirtten in Turkish. Thus Sateh Bey Al-Hussry who was then in charge of the Ministry of Education in Syria said "The Arab Government which undertook the governing of the country in the form of military administration, had to over-come these difficulties and introduce a system of education in order to fulfil its international obligation. It had to re-open the official schools with a new status and new language. The schools had to be increased in number, varied in kind and reformed in curricula, according to the requirement of the new life of the

nation"(1) actually, in order to achieve all these tasks, the Arab Syrian Government carried out the following measures as mentioned by Al-Hussry (2)

- 1- "Arabization" of the old Ottoman schools.
- 2- Organization of the arabic courses in the government offices in order to train the employees in arabic, composition and to transform the registers and from Turkish into Arabic.
- 3- Foundation of the "Scientific or Cultural Academy" and formation of a committee of specialists to select the scientific expressions needed in the teaching of various topics.
- 4- Organization of the special congress for teachers to discuss the problems of education and instruction.
- 5- Creation of training sessions for teachers to acquaint them with the best method of education and instruction.
- 6- Foundation of the review "Education and Instruction" to guide teachers.
- 7- Translation of textbooks and other important books.
- 8- Foundation of "School of Law"
- 9- Re-foundation of the "Ottoman School of Medicine"

Then Al-Hussry adds that: these acts and other enterprises which were accomplished in the brief period of independence, directed education (in Syria) into a national channel, and left a deep and lasting effect which resisted strongly and

(1) Sateh Al-Hussry "Annuals of the Arabic Culture" Printed in Cairo by the Committee of writing translating and publishing 1949, p. 77.

(2) Op. Cit. pp. 77 - 78.

for a long time the policy of education drawn up by the French Mandatory Authorities in the following period". (1) Unfortunately, the period of independence was too short for the realization of all these reforms. Nevertheless, in every level of education the arabic language took the place of the turkish and education in general acquired on the sheriffian regime, a national character (2). The changes in aim method and content were not felt, because the Sheriffian Government did not last more than one year, it gave way to French imperialism called politically "Mandate".

In 1921 France assumed Mandate over Syria and one of its first acts was the control of public education in the Country; the aim being to mould after the French pattern. Program, text-books, language methods etc. were copies of the French education Further-more the French authorities increased the number of French private schools in Syria and encouraged the inhabitants to attend them.

(1) Op. Cit. pp. 77 - 78.

(2) I.A. Babikian "Civilization and Evaluation in Syria and Lebanon", unpublished work, 1938, p. 88 in the A. U. B. Library.

III Science Teaching After The Declaration of Independence.

In 1944 with the independence Sateh Bey Al-Hussry was called by the Syrian Ministry of Education to reform and reorganize the whole system of education in Syria. In his report (1). He criticized the old curriculum of science:

(1) The science curriculum does not take into consideration the relationships between the subjects. The student has to learn botany and zoology, for instance, for two successive years before studying any thing about physics and chemistry. Similarly he has to study geology before learning anything about metals or minerals in chemistry.

2- The second criticism he offers concerns the time devoted to science teaching. The number of periods in the curriculum allotted to the natural sciences, says Al-Hussry, "are few in relation to the importance of those sciences and the role they play in mental education". The time allotted to sciences in the first four grades of the secondary school is ten hours only out of 122 hours devoted to all the courses per week. Even in the science section (2) the number of hours allotted to sciences in the remaining three years does not

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- (1) Sateh Bey A-Hussry "Report concerning the state of public instruction in Syria, and suggestions for its Reform" 1944.
- (2) In Syria Secondary Schools, beginning from the 5th. year, the student has to choose either the arts section or the science section with more emphasis upon science and mathematics in the latter. Those two sections are the only electives in the secondary school.

surpass 19 hours out of 96. If we compute the sum total of the hours allotted to the study of natural sciences through out the seven years of secondary education the number will be 23 or 29 hours out of 218 hours. The following tables show us the distribution of science hours.

Number of hours per week in which the sciences were taught in the first cycle, before Al-Hussry's Reform.

	1st. Year	2nd. Year	3rd. Year	4th. Year	Total
Physics	-	-	1	1	2
Chemistry	-	-	1	1	2
Biology	2	2	1	1	6

Number of hours per week in which science courses taught in the higher or second cycle, before al-Hussry's reform.

	Science Section				Arts Section			
	5th year	6th year	Math Sect.	Total	5th year	6th year	Philo. Sect.	Total
	Physics	3	3	4	10	2	2	2.5
Chemistry	2	2	2	6	1	1	1.5	3.5
Biology	-	-	3	3	-	-	3	3
Total	5	5	9	19	3	3	7	13

Note: The period is 55 minutes.

(3) The third criticism of Al-Hussry was that the difference in curriculum between the arts section and science section was so small that it did not justify the division into arts and science sections. The difference, in the curriculum is shown in the following items per week: half

an hour in geography, one hour in history, one hour in mathematics, one hour in physics and one hour in chemistry, but the outstanding difference exists in the two sections of the final year: philosophy and mathematics. There were in the latter, eleven hours of mathematics whereas there were only four hours in the section of philosophy; and four hours of philosophy in the section of mathematics and eleven hours in the section of philosophy. Al-Hussry ends his report by recommending more emphasis on natural science in the secondary school. (1) So far we agree with Al-Hussry. We agree with him also when he says in his suggestions that secondary education does not imply teaching all sciences nor some notions from every science. But we do not agree with him when he speaks about the aim of science teaching in secondary schools. Hussry writes "we should teach some science which may be judged necessary for general culture, and some sciences which may be judged as the foundation of higher studies" (2) It seems that Al-Hussry still adheres to the traditional aim of education, being preparation. He does not emphasize the concept of growth which we consider the corner stone in our philosophy of education as we shall see in the following pages. That was why the so called reform of Al-Hussry, was more superficial than fundamental.

(1) Saté Bey a. Hussry "Report concerning the state of public instruction in Syria, and suggestions for its Reform" 1944.

(2) *Ibid.*

1) Al-Hussry has not introduced new elements in the science curriculum. All that he did was a reorganization or redistribution of subjects. In chemistry, for instance, the subject matter which was taught in the third, fourth, and fifth years of secondary school is now taught in one year only, the third. The time was one period in each grade, while now it is three hours in one grade. The same criticism holds true for physics also.

2) With the new distribution of subject matter, a great deal is actually taught superficially. Why? Because the redistribution of other courses has not gone parallel with that of science. When optics, for instance has been transferred from the fifth grade to the third where the cases of similarity of triangles have not yet been taught, the student is compelled to memorize Descartes Law and Newton's Law without understanding their meanings and relations.

3) Perhaps it would be better not to teach science at all in the arts section in the higher cycle of secondary schools. For, one hour of chemistry per week taught theoretically is of little value. Furthermore the marks the student takes in this course are considered to have a lower coefficient than the grades taken in history, literature etc... In other words the coefficient of the former course is less than those of the latter courses.

4) The fourth criticism is that when Al-Hussry decreased secondary education by one year, leaving the courses practically as they were, the curriculum has been over-loaded and consequently learning has become superficial. This will not show the

beauty of the scientific method but will rather give an erroneous idea about the scientific pursuit. Adding one hour more to chemistry or physics will not correct this error. That is why in the opinion of many thinkers, the reform of Al-Hussary was rather superficial and formal. This reform has not touched the method of teaching at all, inspite of the fact that method is very essential in the learning-teaching process as we shall see when we proceed further. The method of teaching, unfortunately, remained as it was before, theoretical and superficial. The main reason for this is perhaps the lack of guidance in learning, the lack of laboratories and well-prepared teachers, the lack of good books, the prevailing system of examinations etc... Thus any reform which will not involve all these factors will remain rather superficial.

This state of affairs should not prevent us from seeing some good points in Al-Hussary's attempt.

1) He has introduced a course of general science to the first year of secondary schools and abolished the old Natural History from the first two years. Thus the pupil's mind is prepared for the study of specific sciences through obtaining a general idea about them in the first year. Moreover, they may be advantageous to those who do not finish their high school. This course, if well taught, shows how the different sciences are interrelated and integrated.

2) He has distributed the courses of science among the two cycles of the secondary schools which end with the (Brevet) and the (Baccaloret). Thus the student who leaves the school

at the end of the fourth year for one reason or another, will have obtained a general idea about various sciences. In chemistry for instance, the pupil in the first classes of the third and fourth years studies now some thing about organic and inorganic chemistry, metals and non-metals.

This was not the case before Al-Hussry's change. The student used to study only inorganic chemistry throughout. The whole course of school except in the last class where he was given some organic chemistry. This was the case inspite of the fact that organic chemistry is much more related to his life than inorganic chemistry. The same thing may be said about physics. In the old program the student used to study, during the first four years, some laws of pressure, heat, and machines, leaving electricity optics and sound to the second cycle. The case is different now, the student studies actually during these first four classes principles of electricity, optics, sound, heat, etc... These are very essential and should be taught early.

(5) He has done well when he decreased and eliminated some science courses from the arts section. Formerly, the students of both arts and of sciences studied the same subjects in chemistry through the fifth and sixth years; even in the classes of philosophy and mathematics the difference in the content of chemistry was small. Now there is no chemistry in the fifth class arts and only a few simple principles in the sixth class arts. There is only simple physics in the fifth year arts.

In one word Syria has achieved much in the way of reform and progress after the declaration of independence. The report published by the U N E S C O about "Cultural Evaluation in

Syria proves that :

	<u>1944*</u>	<u>1951</u>
"The budget for education	7 millions Syrian Pounds	30 millions Syrian Pounds.
Number of elementary schools	658 schools	1476 schools.
" " teachers in elementary schools	2337 teachers	5000 schools.
Number of pupils	85000 pupils	202536 pupils.
" " candidates for the elementary school certificate	6000 candidates	9000 candidates.
Number of secondary and intermediate schools	11 sec. and inter- schools.	49 sec. and inter- schools.
Number of candidates for the Baccaloret.	1200 candidates	4000 candidates." (1)

* When Syria was under French mandate.

(1) These statistics are taken from "An-Nazer" a daily news paper in Aleppo No. 3371, 14 July 1951. p. 2.

CHAPTER II

SCIENCE TEACHING IN PUBLIC SECONDARY SCHOOLS IN SYRIA

Public Secondary Schools in Syria are provided and maintained wholly by the state. The ministry of education prescribes the curriculum, supervises its application and guides the teachers in the teaching methods. The science teaching method is an aspect of many, which shows us the method used and the basis on which it is built. We can gain an idea of the level of our schools by discussing in detail the following two points :-

1. The objectives prescribed by the ministry of education.
2. The extent to which these objectives are realized through the teaching methods.

I

The Objectives Prescribed by the Ministry of Education

The aim of teaching in secondary schools may be deduced from the following statements of objectives prescribed in the "Curriculum for Teaching in Syria, 1947."

1. Quantity of knowledge has little value; the important matters that count are the different kinds of outcomes which should

obtain from learning. These are practical, scientific and cultural outcomes.

The value of the practical aim is in its direct application to the different needs of man.

The value of the scientific aim is in the preparation of the pupil's mind to understand its subject and the important theories which are necessary to know.

The value of the cultural aim is to serve the education of the mind, and this can be done by stimulating the mental activities in the class.

Teachers should stress the cultural aim in secondary schools in general and in higher schools in particular.

The most important thing which School Teachers should pay attention to in teaching is not the material itself but the method used in teaching ^{and} the atmosphere of the class.

To obtain these aims the teacher should follow the following suggestions:

- a. The teaching of a limited number of subjects with depth and understanding is more useful than teaching many superficially. Students should assimilate what they are studying.
- b. The best method in teaching is that which makes the student think for himself and participate in class activity. That develops in him self-reliance, thinking and reasoning, therefore, teachers should arouse self-activities in class and outside the class.

- c. The main points of each subject must be clear in the minds of the pupils. Students should differentiate between important and less important points. Teachers should help the pupils to know how to study and how to understand. Teachers can make the main points clear by making the students deduce the summary and write it in the class as they are discussing it.
- d. The extreme dependence on the text book is the worst habit, because it diminishes the value of the lesson. All teachers with their pupils must get rid of this habit. The book must be a guide, not an end in itself. The teacher should make the pupils understand that and should guide them to read and take down notes.
- e. It is very clear that in schools, pupils cannot learn everything needed in life, because they cannot predict all the subjects and problems. Therefore, a teacher should do his best by different ways to make the students understand the main points on which big problems are built. The function of the school is not teaching what is prescribed but it should go forward; it should develop in the pupil the habit of research and reading.
- f. The function of the school is not to develop the pupil's mind only, it should develop morals and character in class and outside the school. It should make students work together on a problem to learn how to cooperate and how to respect one another.

There are many other directions in the published curriculum relating to each subject, from which we can infer objectives. These are some of the directions:

1. Subjects of study should be related to the pupil's life, and teachers should present them as real problems.
2. Related subjects should be taught to help students in understanding and organizing; for example, students should learn some principles of mathematics which are useful in physics and chemistry.
3. Subjects should be presented in such a way as to make the students observe, think, judge and infer, and abstract. abstraction should be built on concrete things to make it clear in the pupil's mind. Teachers should realize that pupils cannot abstract easily without illustrations, especially in connection with scientific ideas. Lessons should begin by presentation of concrete problems.
The teacher should when developing the pupil's concepts take into consideration the pupil's level of understanding and his experience; he should begin with the easiest and go to the most complicated.
4. The application of pupil's concepts and ideas should be sufficient and related to meaningful problems.

In short, we see that the aims of teaching are the development of concepts, functional understanding and the process of problem solving, and the development of attitudes, appreciation, and interest.

II

To What Extent are the Educational Aims in Syria
Realized Through
The Science Teaching Method ?

The level of science teaching in Syria can be shown by studying the parts on which teaching is based.

1. The content
2. The method of teaching
3. The books
4. Evaluation and examinations
5. The teachers

1. The Content

- A. Who prescribes the curriculum ?
- B. How is it organized, and on what basis ?
- C. What are the contents ?
 - (a) The content of all Science Courses in General.
 - (b) The content of Chemistry courses in detail - to be studied now intensively as an example.
- D. What is the student's background for these courses, is it sufficient ?
- E. The time allotted.
- F. The degree of organization.
- G. Conclusion.

A. Who Prescribes the curriculum?

The ministry of education prescribes the curriculum not only for public secondary schools but for private schools also. The teacher has no right to choose his subjects. What the teacher can do is to organize the prescribed according to his point of view. Such liberty, however, is limited by the public examinations.

This is a weak point in our Syrian curriculum, but the ministry of education has an important reason which is the lack of well trained and specialist teachers in Syria.

B. How is content organized and on what Basis?

Science is taught in every class in the secondary school. It is taught in two cycles; the first one consists of four years ending with the Brevet Certificate and the second consists of two years ending with the Baccalaureat.

The aim of this division of the program as is given in the Syrian curriculum book is:-

- (1) To give those who do not intend to complete study or to specialize in science the basic general knowledge of science.
- (2) To allow the students in the first cycle to discover their inclination and decide if they can go for science or for arts.
- (3) The aim of the second cycle is not that it forms a starting point for specialization, but it is an orientation cycle to guide students to a deeper study of science more than is done in the arts courses. Specialization begins in the universities.

The Science courses which are given in the secondary schools are general science, physics, chemistry, biology, and hygiene . The following tables show the distribution of courses and lesson periods:

The First Cycle

	First Year	Second Year	Third Year	Fourth Year
General Science	4 periods	-	-	-
Physics	-	2 periods	2 periods	2 periods
Chemistry	-	-	3 periods	2 periods
Biology	-	2 periods	1 period	2 periods
TOTAL	4 periods	4 periods	6 periods	6 periods

The Science Section of the Second Cycle

	Fifth Year	Sixth Year
Physics	3 periods	4 periods
Chemistry	3 periods	-
Biology	-	3 periods
TOTAL	6 periods	7 periods

For Girls and the Literary Students
In the Second Cycle

	Fifth Year	Sixth Year
Physics	3 periods	-
Chemistry	-	1 period
Biology	-	3 periods
TOTAL	3 periods	4 periods

Note: 1. In the second cycle of girls schools, three periods of hygiene and first aid are taught in addition to the subjects given above.

2. Each period is 50 minutes.

The Content of Science Courses in General

Content of the First Year Program:

In this year students study several topics in about nine unites:

1. Simple machines used by man in his daily life.
2. Water and its benefits to man.
3. The air and its benefits to man.
4. Fuel and heat.
5. The home.
6. The Garden, the Farm, and the Forest.
7. Physical health.
8. Rock and soil.
9. Solar System.

Syllabus of the second year:-

In this year Physics and Biology are taught.

The Physics topics are on simple mechanics, gravitation, hydrostatics, Pascal's principles, Torricelli's experiment and its application, sound. (1)

The topics in Biology comprise the physical structure of man and of a rabbit, the basic characteristics of mammals, birds, the frog, turtle, fish, what is common to the previous animals, and ideas about vertebrate and invertebrate animals. Study of simple familiar insects, spider and crab, snails, worms, crab fish, sponges, the lower animals. (2)

Syllabus of the Third Year:

1. Physics:- two topics : Heat and Light (3)
2. Chemistry :- see page (24)
3. Biology :- In this year pupils study botany, the cell, the parts of the tree, the flower, plant families. (4)

Syllabus of the fourth year.

1. Physics : - two main topics magnetism and electricity. (5)
2. Chemistry :- See page (26)
3. Biology : - Human anatomy, physiology and hygiene. (6)

Syllabus of the fifth year science.

1. Physics :- light, magnetism and electricity.
2. Chemistry :- see page (27)

(1) More details can be found in the Syrian curriculum book, 1947, pp. 90-91

(2) *ibid.* pp. 109 - 111

(3) *ibid.* pp. 91-93

(4) *ibid.* pp. 112

(5) *ibid.* p. 93

(6) *ibid.* pp. 113-116

Syllabus of the fifth year arts.

1. Physics :- the law of gravity, energy and its different kinds, How to produce energy. An idea about musical instruments. Alternating currents. Simple idea about telephone, telegraph, cinemas and televisions.

Syllabus of the sixth year science:-

1. Physics:- Mechanics, energy, wave motion, wave motion in sound, light and electricity. (1)
2. Biology:- Subject is divided into two parts, detailed study of human physiology and botany. (2)

Syllabus of the sixth year arts:-

1. Biology:- The same as for sixth year science.
2. Chemistry:- See page (23)

So far we have exposed the contents of science in general. Let's now have the chemistry content as a particular illustration to be discussed and studied in detail.

b. The Content of Chemistry in the Public
Secondary School

Teaching of chemistry begins as it appears from the table on page (20) in the third year, or two years after taking the elementary school certificate. It is divided into two cycles. In the first cycle no difference is made for girls and boys because science is considered to be just as important in the life of a girl as in that of a boy and it is unwise to present science

(1) More details in the Syrian curriculum book, 1947, pp 99 - 100.

(2) *ibid.* pp. 117 - 119.

as being of importance to men alone. In the second cycle chemistry is taught in the fifth year science and in the sixth year for art students and for girls. What we have to notice is that girls can join the science section and there are special classes for them in Aleppo and Damascus.

Chemistry Syllabus for the Third Year:-

The following subjects are taught in this year:-

1. Air, where it is found, its characteristics, its composition. Lavoisier's experiment. The law of conservation of matter. Verification of the presence of water and carbon dioxide in the air.
2. Oxygen:- The occurrence and importance of oxygen, preparation, physical and chemical properties. The acidic oxides, the basic oxides, the neutral oxides, combustion, the oxidation of metal in the air, respiration is a kind of oxidation.
3. The difference between physical and chemical phenomena. The difference between compounds and mixtures. The difference between elements and compounds. Direct analysis and its method.
4. Nitrogen:- occurrence in nature, preparation, chemical and physical properties.
5. Water:- occurrence in nature, the gases which are dissolved in it, crystallization, the salts found in water, drinking-water, distilled water, distillation, water analysis by direct current, the ratio in volume of hydrogen and oxygen in water. The difference between analysis and composition. The reduction of water by carbon.

6. Hydrogen:- Preparation, its chemical and physical properties, oxidation of hydrogen, its reaction with copper oxide and ferric oxide, the difference between reduction and oxidation, the composition of water, the ratio of components by weight.
7. General chemistry:- Lavoisier's Law, Berzelius's Law, or the law of definite proportions. Dalton's Law or the law of multiple proportion, deducing the idea of gram atomic weight. Atomic weights, symbols. The First and second Gay-Lussac's laws. Avogadro's Law, deducing the idea of gram molecular weight. Molecular weights. The structure formula. The equation, valence, (these subjects of general science must be studied here as an introduction with examples and they must be studied again on every other occasion for good understanding.)
8. Sodium Chloride:- preparation, its properties, the analysis of melted sodium chloride .
Sodium, its reaction with water, the analysis of dissolved sodium chloride.
9. Chlorine:- preparation, its chemical and physical properties, its uses. Javel's water, the chloride of calcium.
10. Hydrochloric acid:- preparation, its chemical and physical properties, its salts, simple idea about acids, bases and salts, simple idea about metals and nonmetals.
11. Sulfur:- Occurrence in nature, preparation, oxidation of sulfur, sulfur dioxide, preparation of sulfur dioxide and its properties
12. Sulfuric Acid:- preparation by contact method, its acidic properties. The most important sulfates. The monobasic and dibasic acid. The salts.

13. Ammonia:- preparation, chemical and physical properties. Its solution in water. The alkaline property.
14. Nitrates:- Sodium nitrate, potassium nitrate, calcium nitrate.
15. Nitric Acid:- preparation, its acidic property and oxydation properties.
16. Phosphoric Acid:- Preparation, physical and chemical properties, preparation of its two kinds, uses.
17. Carbon, its different kinds, properties, use in the reduction of melted oxides.
18. Carbon Dioxide:- occurrence in nature, preparation, chemical and physical properties, its acidic property.
19. Carbon monoxide:- preparation, chemical and physical properties
20. Silicon:- A brief study of it and of silicates, preparation of glass.

Chemistry Syllabus of the fourth year:-

1. Metals.

Sodium carbonate, sodium bicarbonate, lime rock calcium carbonate, calcium, calcium hydroxide, plaster, cement, calcium phosphate. Simple study of the most important properties of the following known metals, iron, copper, zinc, aluminium, lead, tin, mercury, gold, silver and their important alloys, simple idea about the method of preparation. The use of the following metals: chromium, nickel, manganese, magnesium, platinum, tungsten.

2. Organic Chemistry.

The difference between organic and inorganic compounds, the elements which are found in organic matter.

Petroleum:- Preparation, its distillation, composition, general idea about hydrocarbons. Distillation of coal gas, benzine, alcohol, ethyl, their chemical and physical properties. Esterification, acetic acid fermentation, starch, cellulose, the manufacture of sugar and paper. An idea about celluloid and silk. The fatty compounds, their different kinds, the way of preparation, and saponification. Glycerine, the manufacture of waxes and soap. Albumin, casein. Preservation of food.

Chemistry Syllabus for the fifth year Science.

The physical and chemical phenomena, mixtures, pure matter, direct analysis and its method. Analysis and composition. The elements, their classification.

The law of combining weights. Lavoisier's Law. Broust's Law, Dalton's Law, Richter's Law. Wenzel's Law.

The Law of combining volumes:- first Gay-Lussac's Law, second Gay-Lussac's Law.

Law of proportion. Atomic and molecular weights. The laws on which the understanding of atomic and molecular weights depend. Dalton's law, Avogadro's Law, Raoult's Law. The formula and chemical equations. Equivalent weights. Different kinds of chemical reactions:- oxidations, reduction, neutralization, displacement, gravimetric analysis, silver chloride, barium sulfate, volumetric analysis, titration of acid against base and titration of base against acid.

The molecular theory, the structure of molecules, the atomic theory; the structure of atoms, the theory of ionization, the ions

and electro analysis.

Inorganic chemistry:- the properties of metals and alloys, study of iron, aluminum, copper.

Organic chemistry:- Organic matter. The principles of organic analysis. How to find the formula of an organic compound. The hydrocarbons, methane, ethylene, acetylene, petroleum, alcohols, their functions. Acetic acid and acidic functions. Ethyl aldehyde, acetone, ether, ester, fatty acids.

Chemistry Syllabus of the sixth year Arts and Girls:-

Theories about matter:- The atomic theory, the structure of the atom. How to classify the elements. Idea about radioactive elements and applications. The molecular theory, the structure of molecules, ionization, ions and electro-analysis. Explanation of some chemical knowledge and reactions in the light of the previous theories. The structural formulae of some compounds and how they are presented in the plane and in the solid, and explanation of some chemical reactions in their light.

We have seen now the chemistry syllabus of each year including the arts and girls sections. These topics to be well taught by the teacher and well understood by the students must be based upon previous knowledge in the field of science generally as prerequisite to the study of chemistry in particular. Now our task is to see whether the background of the student can help him in approaching chemistry.

D. What is the background of the students?

Pupils who begin the study of chemistry have notions of general science studied in the elementary school and in the first

year of the secondary school. The chemistry subjects studied in this year are on:- "The composition of water as a chemical phenomenon, comparison between chemical phenomena, the burning of sugar the reaction of sulfur with iron, the mixing of sulfur with iron. Analysis and syntheses, preparation of hydrogen and experiments to show its nature. Oxygen, how to verify the presence of carbon dioxide in the air.

A clear understanding of these subjects helps to a large extent to understand what is coming in the third class. The class in which chemistry is introduced as a specific science for the first time in the high school - especially in the first four units which are similar to previous ones. The simple mathematics needed in chemistry lessons as proportion, for instance, are taught for pupils before entering the third class. But pupils are poor in chemical facts necessary for the understanding of the laws of chemistry prescribed for this class because of many factors namely, time of teaching, method of teaching, and the overloading of the curriculum as we shall see in detail.

E. The Time.

For the third year, three hours a week are allotted to chemistry. They are for lectures, discussion, and laboratory work, ^{if} some of the teachers ~~want~~ desire to follow the new method of teaching. This ~~means~~ means the teachers have to cover the syllabus in (66) periods, because public secondary schools in Syria often begin in the first week of November and close at the end of May. One month goes for vacations and two weeks for examinations. What remains is about 5.5 months in which pupils can have (66) periods. If we read the

chemistry syllabus for this year on page (24) we see that it needs at least 80 periods or more besides additional periods for laboratory work. The teacher cannot omit any of the subjects because the pupils must pass in the public examination for the Brevet the following year. In this examination the pupils are responsible for everything prescribed for them by the Ministry of Education.

The same may be said of the fourth, fifth and sixth years.

This overloading in curriculum and this limitation of time results in the impossibility of covering all the subjects and of developing in the students the aims required by the ministry of education or the aims demanded by the educational principles. The teacher is obliged either to teach deeply and carefully and not to cover the program, thus exposing the pupils to failure in public examination or to prepare the students merely to pass examinations. In fact, here every teacher is confronted with this dilemma and has to choose a solution ^{for} this paradoxical situation. Deep understanding of subject matter is an essential implication of sound education; this is so obvious that we need not dwell too long on it. To sacrifice this deep understanding just for preparing for examination, is, in my opinion, completely unjustifiable. Understanding is much more vital than just passing an examination. But unfortunately it seems that, our Syrian teachers are compelled to choose what pleases the inspectors and ultimately the Ministry of Education rather than follow their educational principles and their common sense.

This is as far as time element is concerned. As to organization the question is not much different.

F. Organization of Contents.

a. Chemistry subjects, as we saw, are divided into two cycles in Syria, and this is a good point. It gives to those who do not intend to finish their secondary schools or those who intend to study arts, the chance to deal with chemical phenomena and develop some habits and attitudes and understand some fundamental principles. In this division we find some good points and some weak points.

The good points:-

One of the good points is that the subjects of the first cycles are related to organic and inorganic chemistry - this is what distinguishes the new program and it is meaningful because nature is full of different kinds of matter and compounds, and pupils should understand the local environment.

Another good point is that subjects which are prescribed to be taught in the first cycle are to some extent nearer to the pupils' life; they are about known gases, metals, organic compounds, such as benzene, alcohol. Units which are far from the students' environment are taught in the second cycle such as hydrocarbons, acetone, ester ...

A third good point is that in the second cycle the student has the chance to study some important subject in more detail such as zinc, iron, aluminum, alcohol.. By this way, students know how to follow developmental study.

Let us now consider the weak side of the organization, and we shall be satisfied with two main points.

The weak points:-

Perhaps the weakest point is that things of practical

? value are frequently omitted such as the application of chemistry at home and in life. Few of the children we teach will become research scientists or university professors of science but all of them will become citizens who as a part of the state ought to take interest in public well being, the health and the happiness of their fellows:

? The second weakness is that subjects of vocational value are overlooked. You often find no emphasis upon the manufacturing of soap or glass and cement, while you find an overemphasis upon sulfuric acid, phosphoric acid, etc. Thus the practical side is almost always lacking in our schools, and this is the greatest shortcoming in my opinion. This is only a brief survey of the organization. However, some other weak and good points in the curriculum will be seen after the evaluation of the content in general.

b. A critical study of the Content in General.

? ? From reading the table of contents, we see that related subjects are prescribed for one class or that they form a sequence. This is a good point in the program. It helps students in understanding, organization and classification. Nevertheless, it will be better if these arbitrary and artificial divisions, called chapters are organized into units or meaningful wholes. Noll suggests in his Book "The Teaching of Science", the same idea when he says: "Text books of high school chemistry may have separate chapters on acids, bases and salts, neutralization and hydrolysis. A unit in neutralization would include all these concepts. Again instead of having six or ten separate chapters on metals, they may be one

unit on metallic elements?⁽¹⁾

A serious deficiency in the chemistry program in the secondary school is that most of the course seems to lack human interest. The materials are organized according to the interest of the scientist rather than according to the interest of the secondary school boys and girls. It was in this connection that Noll stated in his book the "Teaching of Science" the offering in a given science aims to give the pupil a comprehensive view of the subject matter of that science rather than that insight and technique which will be of the greatest value to pupils in meeting the problem of everyday life.⁽²⁾

Instead of giving the chemical laws dogmatically at the beginning of the course as is done in the third class, it is better to withhold them until the pupil has become familiar with a considerable number of compounds and some of the properties and the percentage composition. The pupil cannot realize the significance of the law of conservation of mass by making him memorize it or by explaining it with limited examples. Explanation may be very interesting if it is about experiments done by the pupils in the laboratory. Also the law of definite proportion cannot be understood without finding the percentage weight of elements in each compound by experiment. The same thing may be said of the law of multiple proportions; to understand it the pupil should know at least the composition of water and hydrogen peroxide, sulfur trioxide, the oxides of nitrogen. By studying these oxides and

(1) Victor H. Noll. "The Teaching of Science in Elementary and Secondary Schools" pp. 60, Longmans, Green & Co. 1942.

(2) *ibid.* p 10.

and seeing the relation between them the pupil can discover the law himself and he can understand it better if he has had enough experience. Also the student's knowledge of the Gay-Lussac's law ^{should} be made to grow out of his experience with certain compounds, such as the combination of oxygen with hydrogen at the same temperature and pressure, the combination of nitrogen with hydrogen to form ammonia, the combination of hydrogen with chlorine to form under similar conditions hydrogen chloride. (1) The real knowledge of laws or principles can be gained only by practice in dealing with sufficient problematic situations in which they are involved. Thus we agree fully with Twiss who said: "Words, definitions, statements of laws and principles, algebraic formulae, are mere symbols. They are indispensable in science for economy in thought, but they are absolutely useless to any individual unless he himself, has a clear and precise notion or concept of the things or relations for which each symbol or law stands." (2)

Indeed education does not end at the age of fourteen or fifteen and one of the weaknesses of our present system is that subjects are organized in a way which makes the student feel the chemistry ends at school. Subjects should be presented in a way which may develop satisfactory hobbies that may absorb a good deal of the pupil's time, thought and activity and help him to retain his equilibrium in later life.

(1) More details about the teaching of chemistry laws are found in G. R. Twiss, "The Teaching of Science", pp 262, 379. New York, the Macmillan Company 1938

(2) *ibid.* p. 294.

Our Syrian program does not contain any indication of the present position and progress of science. This is very necessary so that we may obtain an adequate understanding of the world in which we live. This deficiency should be rectified as soon as possible; otherwise we remain where we are. In other words we lose our touch with the progressive world around us.

Most of our subjects do not show the influence of science in the social and economic developments, and an influence which is one of the most significant features of our modern civilization.

Subjects which show the pupil the extent to which science and chemistry have served humanity are in the Syrian program very briefly treated or are omitted. The introduction of some historical knowledge on the development of sciences and their influence upon the people, is very imperative. Concerning this point, Conant in his book "On Understanding Science" suggests special courses in the history of science to be studied at the college level as a way for teaching science to the layman and to those who are not going to be scientists. His objective is "to give a greater degree of understanding of science by the close study of relatively few historical examples of the development of Science". (1)

The chemistry curriculum does not include sufficient content on food, health, building materials and clothing, inspite of the importance of such items in the daily life.

The pupils in our schools are introduced into highly specialized operations which they will probably never have to meet

(1) James B. Conant, "On understanding Science" and "Historical Approach." p. 16, New Haven, Yale University Press, 1947.

again after leaving school. Subject units should have a real connection with the common operations of every day life. The study of important units such as the manufacture of glass, cement, sugar, paper, starch, is brief. I think that pupils like to study such units more than any other subject in chemistry such as writing formulae and equations of some complicated reactions. Moreover, the teaching of such alive subjects motivates students and helps the teacher in making his lesson more interesting and useful, which in turn makes easier the introduction of fundamental principles after-wards.

Thus we can conclude that the general weakness in our curriculum lies in this big discrepancy between the school and society or between theory and practice in general.

So much for the content. The method of teaching in our Surian Schools ^{will be} discussed in the following section.

2- The Science Teaching Method in Syria

Generally speaking one can say that two methods are mostly used in science teaching in Syria, namely the lecture method and lecture demonstration method. The first method is used often in schools which do not possess enough equipment and visual aids. The second is used in schools which to some extent have equipment and laboratories, but unfortunately ~~that~~ the first method is the more dominating, because of the general lack of laboratories and well trained teachers. For example, there are now six public secondary schools in Aleppo, two of which only have laboratories, one for chemistry and one for physics. No laboratories for biology exist. In the biology lesson teachers bring their very limited visual aids to the classroom for demonstration. However, both methods have some value.

What are the values of these two methods:-

The lecture method and lecture demonstration may serve for ~~arousing~~ interest or for motivation.

The teacher can in these two methods simulate life situations.

They are ways to develop in pupils some mental values. Pupils may be trained by them to acquire audio-discrimination as well as the power of visual discrimination, since much of actual life is concerned with various forms of the lecture.

The lecture provides opportunity to contribute supplementary data.

A formal lecture of 45 - 50 minutes may be very valuable way of showing the student the relative merit of the several

aspects of any problem and incidentally of revealing to him desirable techniques by which to evaluate and there by gain better perspective.

The lecture provides opportunity to reorganize and clarify defective textbook treatment. Often textbooks are not sufficiently clear to immature minds because of the forced condensation.

The lecture enables a large field to be covered in a short time and at the same time it arouses enthusiasm.

Experiments of more difficult character or those requiring highly complicated apparatus can only be performed at all as demonstration.

The lecture demonstration is useful with beginners in chemistry and with a large class, and can be used to test pupil's hypotheses.

Demonstration may be used to develop skill in the interpretation of data.

The weaknesses inherent in the lecture method and lecture demonstration are as follows:-

The lecture invites passivity instead of activity on the part of students. Subjects which are taught in ways which fail to keep the student in an active learning situation, and which fail to provide increasingly difficult problems thereby constantly offering a challenge to his ability to think and to manipulate soon kill all interest in chemistry, and they not only fail to accomplish the objectives of science but in addition actually do the student harm. How many students who might have been chemists are lost because they never had a chance really to explore the field, and as Dewey said: "When

education, under the influence of a scholastic conception of knowledge which ignores everything but scientifically formulated facts and truths, fail to reorganize that primary or initial subject matter always exists as matter of an active doing, involving the use of the body and the handling of material, the subject matter of instruction is isolated from the needs and purposes of the learner, and so becomes just a something to be memorized and reproduced upon demand". (1)

Most students are unable to analyze a lecture and summarize its salient points, especially in science subjects which must be built on concrete experiments and by losing the main points of the lesson they will find all to be vague to them, and time will have been practically wasted.

The treatment of science subjects by the theoretical or demonstration method is often dull. Very often the teacher feels that simple apparatus is the only form of illustration about which he needs to trouble. Actually he should use lots of illustrative materials in the form of diagrams lantern slides, films etc.. To give an example, the latent heat of evaporation of water is taught as I observed by a number of routine simple experiments, an equation of some complexity, and the matter is left at that. Useful application of the principle and deducing from it other principles, such as the cooling of porous water vessels in hot places, and the effect of evaporation of perspiration on the human body are over looked. By this way the whole pupil's experience is not employed and there will be an

(1) John Dewey "Democracy of Education" p. 217. New York, The MacMillan Co. 1950.

artificial gap between life and the school.

Frequently the numbers or quantities involved are merely learned in parrot fashion without an understanding of their real significance, as Dewey has said: "Knowledge which is mainly second-hand, other men's knowledge tends to become merely verbal". (1)

Experiments used in illustration are used for clarification not for raising problems to be solved in the class by students with the help of the teacher.

The teacher finds difficulty in arousing mental alertness and activity on the part of the listener by the lecture method.

No assurance is possible that the audience is attentive and is receiving what is given, or that what is received is understood.

The rate may be too rapid to allow pupils to get the necessary connections of thought.

Pupils in general are unskilled as listeners and there is minimum stimulation to critical evaluation.

The lecture method and lecture demonstration do not satisfy one's desire for knowledge and self-confidence, nor do they enable one to handle better life situations which he meets in life afterwards.

These two methods do not develop the initiative in an individual, the habit of ascertaining what should be done, and understanding to do without being told. These objectives are more valuable than any ability to pass examination

(1) op. cit p. 221.

in class work. Confidence in one's ability and self-reliance are fundamental in the educational process.

Brownell has said: "Teaching as a process implies not only that some one gives instruction, but as well some one wants to be taught. It is a mutual matter, mind acting upon mind. Action and reaction if not equal are at least in evidence".(1)

Many of the generalizations and principles may be thoroughly understood without actual contact with the concrete materials of chemistry. But many facts and the understanding of important processes can only be finally learned after the pupil has had contacts with actual materials involved. By "first had contacts", the pupil is capable of understanding the more abstract instruction that follows.

"The inductive and the deductive methods are equally important and both are essential in every science class. The inductive method should in most cases be used first in order to develop an understanding of a principle or a concept. The deductive method, with its application of these principles and concepts should then follow. Teaching by the inductive method consumes much time, but the potential outcomes abundantly justify the time invested".(2)

(1) Herbert Brownell and F.E. Worde "The Teaching of Science and the Science teacher" New York and London, the Century Co. 1925, p. 78.

(2) "National Society for the Study of Education" 46th Year Book, p.49 Part I. Distributed by the University of Chicago Press. Chig. 37. Illinois 1947.

Lecture method and lecture demonstration do not allow the students to pick out some interesting aspects of the subject and to study them in more detail and at greater length.

They do not enable the superior students to do a great deal of work at odd times. Students who are able to proceed alone should be encouraged to do so. These two methods do not work toward more correlation with other departments in the school. For example, the writing of long papers and reports requires the pupil's use of principles learned in Arabic lessons.

They hinder the development of many attitudes and habits (discussed in Chapter IV). (1)

Therefore better methods should be used. This point is discussed in detail in Chapter IV.

(1) More development is found in:

- a. Nelson L. Bossing "Progressive Methods of Teaching in Secondary Schools" pp. 437-450. Houghton Mifflin Co. Boston, New York Chicago.
- b. W.L. Sumner "The Teaching of Science" pp 31-42 Chap.IV. Oxford : Basil Blackwell, 1947.
- c. Arthur G. Haff "Science Teaching" p. 144 Chap. IX. Philadelphia. Blakiston Co. Toronto, 1947.

3- Text-Books

In this part I intend to discuss and present:-

- A. The method of selection of textbooks in Syria.
- B. Evaluation of the texts used.
- C. The method of using books in Syria.

Let us now begin with the first point:-

A. The Method of Selection of Textbooks in Syria:-

It is neither practicable nor advisable at this stage that the teacher in Syria should have the right to order select the textbooks. He may recommend, leaving the final decision to the superior, with whom this responsibility undoubtedly should lie. The reason is that most of our teachers are not sufficiently well-trained for assuming this responsibility, and because Syria follows a centralized system in education.

B. Evaluation of the Textbooks used:-

To know the standard of our books it is necessary to have them evaluated from different points of view:-

- a- Subject matter.
- b- Organization.
 - 1) the subject matter.
 - 2) learning exercises.
 - 3) information.
- c- Teaching aids.
- d- Educational position of the author.
- e- Mechanical make-up and cost.

Let us now begin with point (a)

a. The subject matter:-

Textbooks are written to meet the demands of the syllabi

prescribed by the Ministry of Education. Therefore the same criticism could be applied to them as to the content.

The essential topics included are those which help pupils to pass examinations and not those which are based on environment, interests and activities of the pupils. Therefore our books never meet the real need of the pupils.

The practical applications of the subject matter are rare. Students who study, for example, acetic acid, acetone or any other topic can find in the books the structural formulae, some complicated equations, but not any thing about use in life, at home or in industry.

There is no provision in the subject matter for "local essentials" which are suited to a particular community, the materials are the same for all Syrian girls and boys.

No supplementary materials are in the books to broaden the pupil's mind or give opportunity for individual differences.

Most of the subject matter is not socially worth while, because of its kind and bad presentation.

There are some defective definitions in the books. "Jamal-El-Farra" in his chemistry book for the fifth year science defines oxidation as combination with oxygen, and oxidizing agents as those which give oxygen to oxidize another compound. He defines reduction, bases, acids in the same way.

b. The organization in the textbooks:-

1) the organization of subject matter:-

The subject matter is arranged in units under which ⁿmay problems are raised. For example under the unit of the general law of combination in the fifth year chemistry book,

Lavoisier's Law, Broust's Law, Dalton's law, ... are discussed. Under the unit of hydrocarbons, ethylene, acetylene, petroleum are explained. But the weakness is clear in choosing these units. Some of them are meaningful, because they are related to the pupil's life, such as the units of water, air, metals, but some of them are not interesting to pupils because of the abstract presentation, such as the law of combination the formulae and the equations, the physical laws of atomic and molecular weight. Such subjects can be learned under a practical project undertaken by students, or they can be inferences obtained from many concrete units studied by the pupils.

The units in the books are of reasonable size. They can be divided according to the teacher's need. They are organized for teaching by the lecture method, and are not presented in the form of problems.

The sequence of units is not very good, we find, as an example under the unit of bases, a reaction between sodium hydroxide and ethyl acetate giving sodium acetate and alcohol before the study of acetic acid and ethylene. The interpretive materials should come first.

The texts are organized according to the logical development of the subject and give no thought to the psychology of learning, nor to the real needs of high school and college pupils. The materials are not presented in problem form, and no successful attempt is made to present the units in a way that would appeal to the student as being worth while solutions to problems. All units are presented and discussed

in the same way. The author speaks first about the occurrence of a compound or an element, the method of preparation, the physical and chemical properties. This way of presentation kills the scientific attitude and does not give the pupil the chance to use the real scientific method in discussing matter from the chemical point of view.

Most of the books do not contain a brief summary of the units showing the major items. In some of them the important points are underlined.

No provision for individual problems or projects, is made.

2) Organization of the learning exercises:-

Our science books do not include well-developed sets of laboratory exercises, and for the exercises found, there are no directions to help teachers or pupils in determining what is required. No correlated laboratory manual is provided.

After each unit, some stimulating questions are presented. They are of different kinds, taught questions, memory questions, and numerical problems to provide instructions and drill in the mathematical aspect of chemistry.

These questions increase in difficulty to provide opportunity for individual differences. What is missing is the self testing or learning exercises.

3) Organization of information:-

No information is found in our science books, such as bibliography of additional references at the end of each unit, suggestions of material for projects, list of books

and pamphlets of value to teachers, some sources of slides, films, pictures, and other teaching aids, sources of industrial materials, adequate tables of content, adequate indexes, and separate teacher's manuals.

c. Teaching Aids:-

Our science books contain a limited number of demonstrations. They are well distributed through the books but they are not of real teaching value. The pictures are not large enough to bring out the important details for which an illustration is intended. Maps, graphs, diagrams and charts are very rare.

d. Educational standing of authors:-

Most of the books are written by specialists, some of whom hold a Ph.D. in the field of science, besides experience gained in teaching.

e. Mechanical make-Up and cost:-

Science texts are of conventional size and shape, but they are not attractive. The paper is not of good quality, printing is not very clear, and binding is not durable.

G. The Method of Using the Science Textbooks in Public Schools:-

Science textbooks are the sole source of information. The teacher assigns some pages in the text to be learned by the pupils and be discussed by the teacher in the class, and to be recited afterwards before the teacher who asks questions and develops discussion as best as he can. Most of the teachers attempt to cover the whole subject in the book.

This way of using texts has some advantages and many disadvantages. It is desirable not to get rid of the textbook because any textbook is likely to provide better materials than the average teacher can assemble, and the learner gets a right

conception of the importance of each topic and its relationship to the subject as a whole, especially if the book is well selected and if it provides a good general outline of the course. But this method of using books leads to reduce accomplishment in quality and quantity. Teachers become task masters and lesson hearers. Pupils come to memorize rather than learn. The course of study becomes a body of material, not to be agreeably assimilated by pupils.

The textbook should be a source of information, inspiration and enlightening ideas, and students should be directed to it to get the benefit of what has been achieved upon these topics by others and what is taught about them by the best authorities.

In fact it is not the subject matter that the students carry away, but the attitudes and the method of study and attacking problems, and the like. The use of the text should follow rather than precede introductory laboratory exercises which enable a class to gain some first hand acquaintance with the topic by contact with it in the laboratory. Twiss asserts:- "It is very wrong to send pupils to the book before hand to find out from the printed pages what they should find out with their own eyes, noses and hands" (1). Pupils after accumulating a considerable amount of facts through first hand experience are in a position to use chemistry books with

(1) George P. Twiss "Principles of Science Teaching" p. 352.
New York, the MacMillan Co., 1938.

right attitudes.

What our teachers need is that they should feel free to teach less material in order to teach it better. The less capable the class the more limited should be the amount of materials planned for study, and the teacher should not proceed before the pupils understand all the desirable major points.

4- Examinations

To find to what extent examinations serve their purpose, in Syria, it is advisable to discuss the following aspects:-

- A. The aim of examinations.
- B. Types of examination procedure.
- C. Preparation of questions.
- D. Character of questions.
- E. Grading.

A. The aim of examinations:-

Examinations in Syrian public schools are justified on two counts. It is said in the first place that they help in raising the standards of teaching, and secondly in insuring that the subject is properly taught. But I think that raising the standards is achieved by having more adequately trained teachers better equipped schools, better libraries, and laboratories, and through systems of supervision which help keep the teachers alert and create in them a sense of professional pride and responsibility.

B. Types of examination procedure:-

Two types of examination are employed:-

1. Oral and written quiz.
2. Essay examinations - mid-year and final examination (1)

The aim of the first is to train pupils in oral response which will be the dominant form out of school activity and later, to motivate students to study during the year and to diagnose pupils' weaknesses.

The aim of the second type is to give every one the chance to participate and the time to think.

(1) Article 28.

G. Preparation of questions:-

In ordinary quizzes or examinations, the teacher makes out a set of questions or problems and the pupils are required to write the answers. But in public examinations, questions are set by the central offices of the Ministry of Education instead of by the teacher himself. In such cases the magnification of the importance of examinations tends to make them an end instead of means, and students become on the whole unwilling to pay much attention to studies that are not included in the public examination. School education becomes to a large extent a preparation for the examination, and therefore examinations act as an obstacle to experimentation, proper learning and progress.

The purpose of examination should be to test ability and functional understanding, to diagnose both class and individual student weaknesses, to recall essentials of the subject, and to show students whether or not they themselves have selected essentials when preparing for examinations.

D. Character of questions:-

The questions are of different kinds, problems, description of some simple experiments, and discussion of some points. In article 8 of the instructions to examiners, it is stated that questions should be selected in such a way as to measure the student's achievement and to diagnose his mental ability, but in fact they do not.

Most of the examination questions are not a means of guiding pupils into correct study habits because they test memorizing of what has been taught in class and what has been studied in the text, but not the pupil's observations or

experiments performed for him and by him or his ability to interpret his local environment in the light of what he knows. The usual questions assess the student's ability or success by what he says not by what he does. "The teacher should try to direct all his teaching, examinations included, toward fitting the pupils to react efficiently in the situations of daily life - both the present daily life and the daily life in which they will find themselves when they have become adult citizens and workers". (1)

The questions are not representative of the whole field; they are limited in number, not more than three or four to be answered in 125 minutes. A test like that will not yield a reliable picture of what the student knows. Normally the more extensive the sampling, the greater is the likelihood of high test reliability. Adequate sampling is impossible with so few items. All the tests are not standardized and therefore they cannot be said to be highly valid. The questions are of the same degree of hardness and hence individual differences are overlooked. Such questions have undesirable effects on the pupil; they do not encourage him and put him through a mental "warming up" process before he meets the different items. No tests are given to examine technical skill which may be of great advantage to almost every one.

B. Grading:-

The grading is by the percentage plan "The grades should be between zero and 100. - Article 11 of the instructions.

(1) George R. Twiss "Principles of Science Teaching" p. 447,
New York, the MacMillan Co., 1938.

But in public examinations, papers should be corrected by special committees. (Article 29), and those who correct the papers can not know the name of the pupil whose paper they are correcting. There is in the system therefore the element of mistrust towards school authorities. Principals and teachers are not depended upon to judge the progress of their own pupils, and to base upon this judgment the recommendation for the granting of school certificates. It is said that teachers and principals if left to themselves become subject to pressure from parents and people in authority. The responsibility, therefore, is taken out of their hand and laid on the higher authorities.

Naturally this does not make for high morals or sense of responsibility among teachers, both badly needed in our system. Rigid examinations create mistrust in all the teaching body.

In public examination, only the grade of the examination counts, and this grade has a double coefficient in the science division. That is not right. Many students can pass at the end of the year, although their daily work is all the time below passing grades, owing to the unreliability of the examination. The final school examinations count for less in making up the final grade. Final exams and every examination should not be held up before students as a spectre to scare them and as a source of neurotic worry. All the tests are not standardized and therefore grading is unreliable especially if the papers are corrected by untrained and unspecialized teachers.

I disagree with this way of grading as it assumes that an examiner can assess achievement within 1%. Bossing said: "Psychologically it is inconceivable that any student in a class who had put forth any effort would not have learned something, yet it is possible for a student to take a new type of essay examination, fail all questions, receive a grade of zero, and still have a considerable fund of knowledge of the subject. It is equally impossible to measure perfection .. (2) I shall take up this point in Chapter IV,.

In ordinary school examinations, each pupil's paper is graded by the teacher who estimates the value of each answer - article 29. The grades of the oral quizzes and mid-year and final examinations influence on the final grade. School grading is as follows:-

1. Taking the average grades of the oral quizzes for the first semester.
2. Taking the average of the oral and written quizzes for the second semester.
3. Adding these two averages to the grade of mid-year examinations and dividing the result by three.
4. Adding this final average to the grade of final examinations and taking the mean which is considered as the final result. (Article 22).

(1) Nelson L. Bossing "Progressive Methods of Teaching in Secondary Schools" p. 755 Houghton Mifflin Co., Boston, New York etc.

5- Preparation of Teachers

Teachers for secondary schools in Syria are prepared now in two ways:

1. In the school of science and the Higher Teachers Institute which were established in Damascus in 1946.
2. In foreign universities.

The aim is the preparation of well trained teachers for secondary schools. (1)

In the school of science the students study science courses and in the Higher Teachers Institute they study some education courses only. The whole course for these two schools together is four academic years. The subjects of science with the periods are shown in the following table:

	First Year	Second Year	Third Year	Fourth Year
General Mathematics	6	-	-	-
Physics	8	6	6	8
Chemistry	8	6	6	8
Geology	-	-	-	5
Biology	-	9	9	-
Foreign languages	2	3	3	5
Total	24	24	24	24

Note:- The period is 60 minutes.

Half of these periods are devoted for laboratory work. The school council is responsible for the distribution of hours between the theoretical and laboratory work.

(1) Article 1, of decree 1003.

The education courses which are given in the Higher Teachers Institute are psychology, principles of general education, general teacher training, special method, history of education, practice. They are distributed as follows:-

	1st. Year.	2nd. Year	3rd. Year.	4th. Year.
Psychology	4	2	-	-
Principles of Ed.	2	-	-	-
General teacher training	-	2	-	-
special method	-	-	4	-
History of Ed.	-	2	-	-
Practice	-	-	2	6
Total	6	6	6	6

Students for these schools are selected by a special committee consisting of three members under the chairmanship of the head of the Higher Teachers Institute. Selection is made after a study of the applicant's qualifications and a personal interview, the purpose of which is to determine the adequacy of his mental ability, personality and physical appearance, and suitability for teaching. A written examination may be required besides the oral interview (1).

The project of preparing teachers is very useful because the percentage of specialized and well trained teachers is very low in Syria. The combination between subject matter and professio-

(1) Art. 6 of decree 1003.

nal training is obviously highly advantageous. The practical courses in the educational program are left for the last two years after the students become acquainted with the principles of education and learn a lot about science principles of education and learn a lot about science subjects. Another strong point in the program is that students study related courses such as physics, chemistry and mathematics that help them in teaching and give them a broad idea about science. The foreign languages help them in their studying and future work, because Arabic reference books in science are very rare.

The percentage of education courses is somewhat low; it is about 20% of the total courses. I think it should be about 30%. I shall discuss in chapter 5 how the teachers should be prepared for Syrian schools and what their qualifications should be.

Chapter III

Evaluation of student's achievement according to Powers general Chemistry test.

We saw in the previous parts the weak points in content, method and evaluation. To ascertain to what extent these aspects influence the teaching of chemistry I tried this abovementioned test in one of the best public secondary schools in Aleppo. The aim has been to measure the degree of success according to a standardized test, and to diagnose pupils' weaknesses and interpret the reasons. By this test we can, too, compare our pupils' achievement with that of American pupils.

Power General Chemistry Test

By

S. R. Power, PhD.

Description and Purpose of the Test.

This test is designed primarily to measure the accomplishment of pupils in high school chemistry. It is not based upon any single text book in chemistry, nor is it intended to apply to any particular type of course of study in this subject.

There are two parts in the test. Part I is a test of range of information about chemistry. It is composed of 30 items. These items test a wide range of knowledge, including chemical properties, chemical composition,

commercial processes and terminology.

Part II consists of 37 items and tests ability to write formulas and equations, to give the chemical names of common substances and to do simple calculations.

This test is published in two forms designated as form A and B, which have the same types of items, and they are of equal difficulty. The test items are arranged in order of difficulty; the range is from very easy to comparatively difficult items. The range of difficulty of part one is nearly the same as that of part II. The time allowed for the test is 35 minutes.

The Test:-

I tried form A of Powers General Chemistry Test, because it contains materials studied by our pupils. I exchanged in part I questions number 14, 16, 22, 27, 28, 29, 30 for questions number 4, 9, 11, 22, 25, 28, 30, in form B, and in part II, question number 23 by question number 12 in form B. The reason is that the material involved is not prescribed. The test was given in Arabic but the English version is appended to this Thesis for reference.

(1)

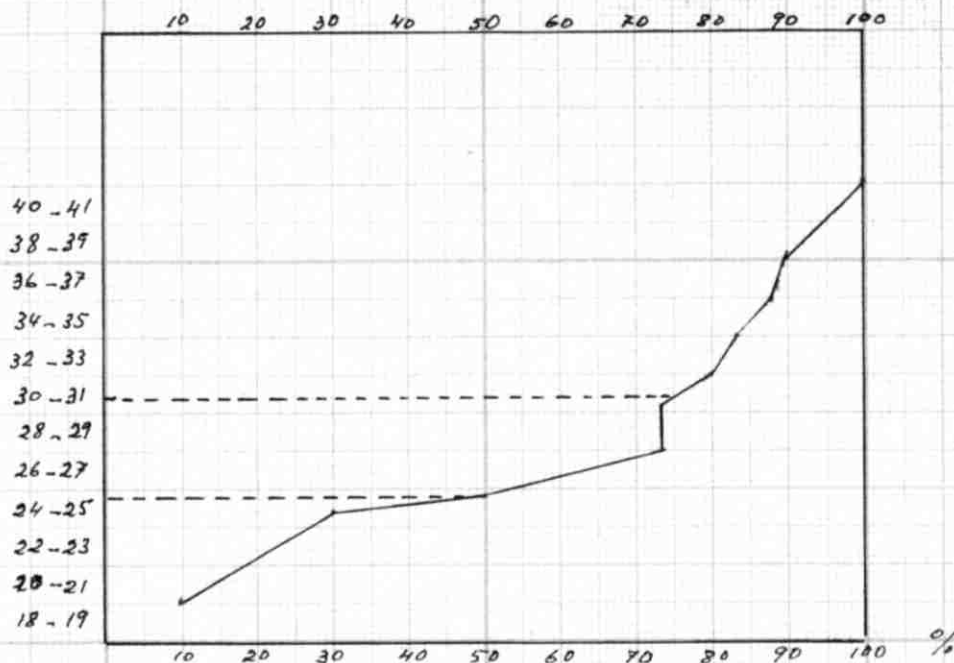
(1) More informations can be obtained from the test itself

Published by World Book Company, Yonkers-on-Hudson,
New York and 2126 Prairie Avenue, Chicago, Copyright 1924
by World Book Company.

The Result of the Experiment:-

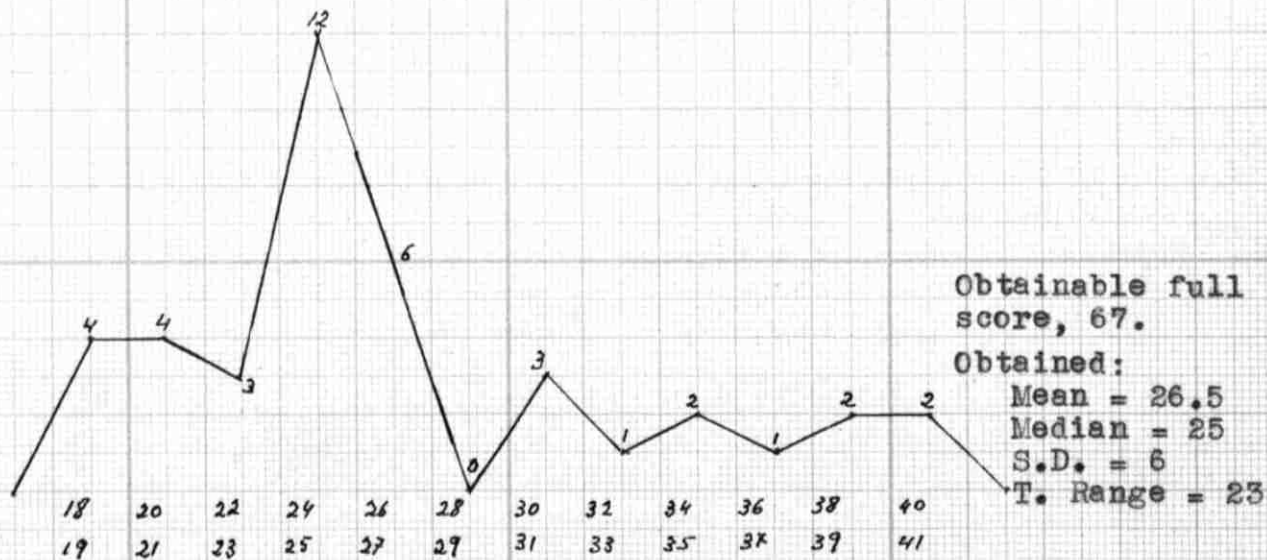
In the following pages the results are given first graphically, then the interpretation.

These are the results of 40 students in the fifth year secondary school. They studied chemistry for three years, in two of them 3 periods a week, and in one of them 2 periods a week. Each period is 50 minutes.



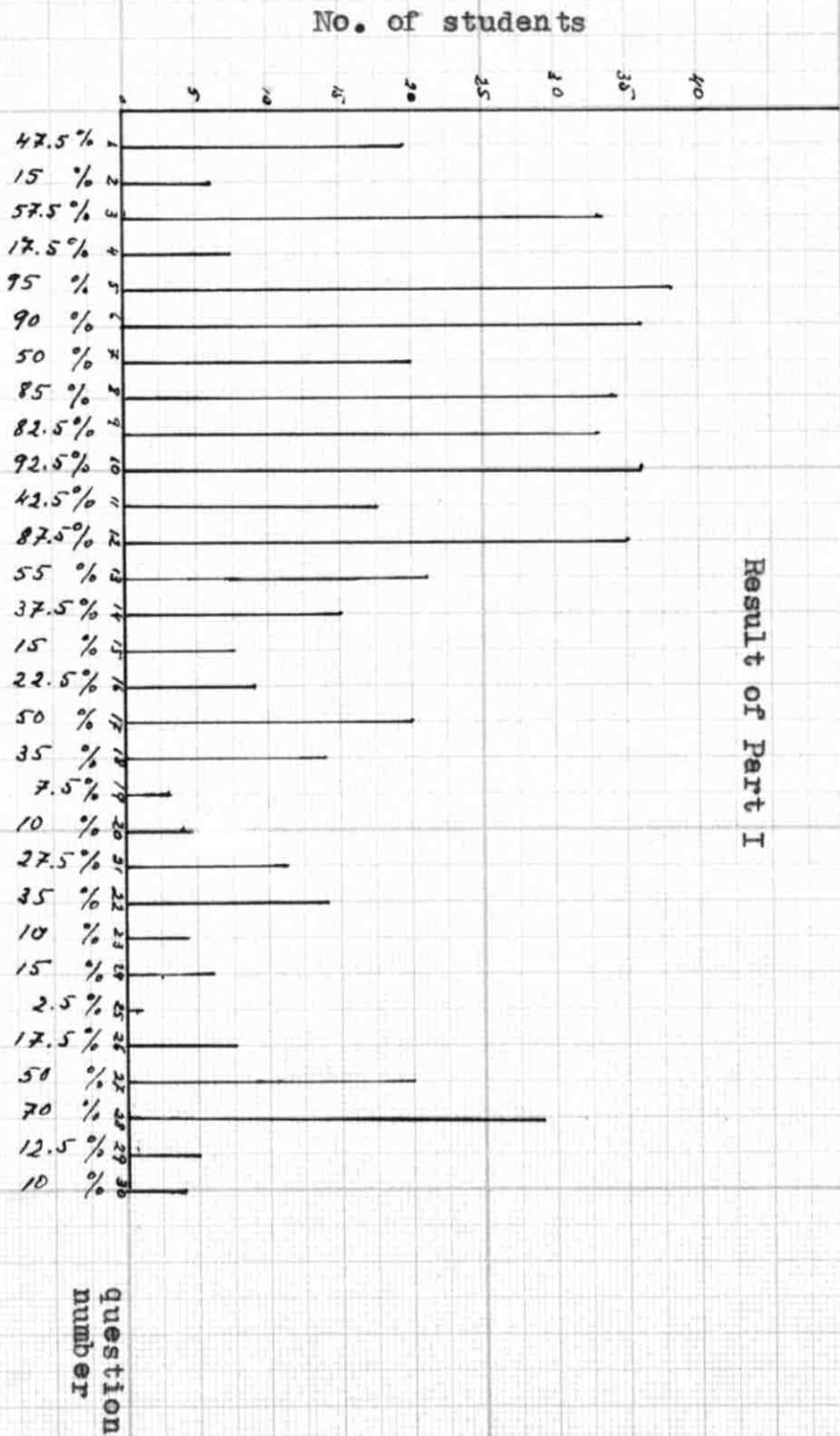
Percentile graph, "Ogive" for the chemistry students, Score distribution of the fifth year science "Lycee of Aleppo".

No. of students 40 boys.



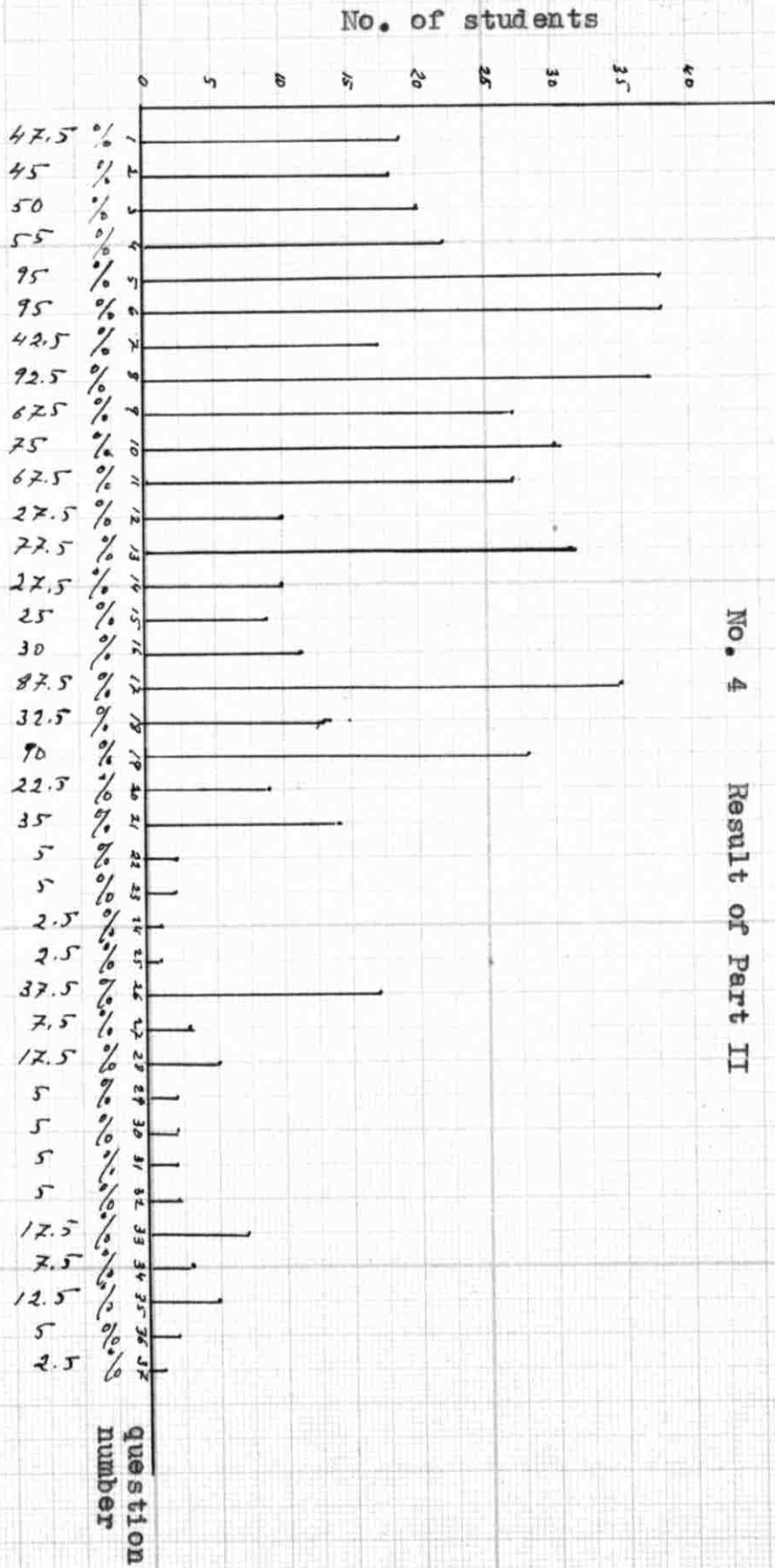
Distribution Curve

N = 2



Result of Part I

$N = 3$



No. 4 Result of Part II

Interpretation and Utilization of Results:-

In figure (1) which contains the percentile graph, the scale on the vertical line is scale of scores. The scale at the top and the bottom indicates percentile ranks. The curve cuts the 50 percentile line at a height representing a score of 25. This means that a student making a score of 25 exceeds 50% of the pupils. The curve cuts the 75 percentile line at a height representing a score of 29.5 showing that a student making a score of 29.5 exceeds 75 per cent of the students etc...

Graph No. 2 is the distribution curve which shows the distribution of students in relation to the score axis. The full score obtainable is 67.

The mean is	=	26.5
The median	=	25
Standard deviation	=	6
Total range	=	23

Graphs No. 3 and 4 show the number of students who answered each question and their percentage. No. 3 is for part I and No. 4 is for part II of the test.

Interpretation of Graph No. 3 Part I.

From this graph we see that more than 50% of the pupils answered questions, 3, 5, 6, 8, 9, 10, 12, 17, 27. The reason is as far as I can see is that these questions have a great relation to pupils' life. That is an evidence which shows us how students understand and do not forget facts related to their own life, and ideas based on concrete matter known by them.

From 25% - 50% of students answered questions 1, 11, 14, 18, 21, 22. This group of questions depends on understanding the meaning of some technical words and on memorizing and understanding the nature and structure of some compounds, their uses and applications. If our pupils had understood the real meaning of each word as oxidation, reduction and had done some experiments and applied what they studied, and if their learning had been based on reasoning the result would have been better.

From 12.5% to 25% of the students answered questions 4, 15, 16, 24, 26, 29.

This shows that the pupils are weak in reasoning, understanding and practical applications.

The percentage of students who answered questions No. 19, 20, 23, 25, 30, is very low. It is between 10% and 2.5%.

This is another evidence of weakness in the teaching method.

I believe that students who use alum to coagulate the colloidal material in water will not forget its function. Especially our students who live in an environment that may have to use this method to make the water pure. If our students had understood the nature of acids, how they ionize and how the increasing of ions influences the direction of the reaction. They could have deduced that the increasing of acetate ions from the salt influenced the reaction and decreased the hydrogen ion concentration.

Studying the results of part II shows us that :-

Above 50% of the students answered questions 3, 4, 5, 6, 8, 9, 10, 11, 13, 17, 19. The reason, as I believe from study-

ing the nature of these questions, is that most of them are about simple points, some need simple calculation not more than substitution and addition, such as questions, 8, 13, 19, or they involve writing the structural formulae of simple compounds as in questions 9, 10, 11, or writing the name of simple formulae as in question 17. Those who know nearly the name of each compound can write the formulae because most of the compounds are composed of two elements.

The percentage becomes less in questions 12, 14, 15, 16, 18, 21, 26. It is from 25% to 50%. The reason is that these questions are more complicated; they are about writing the structural formulae of compounds composed of more than two elements, or writing the name of these formulae as in questions 15, 12, 16, 21. The writing of such formulae needs understanding the valence and knowing the elements involved. The other question is a simple problem the solution of which needs understanding and knowing the volume of a mole of gas.

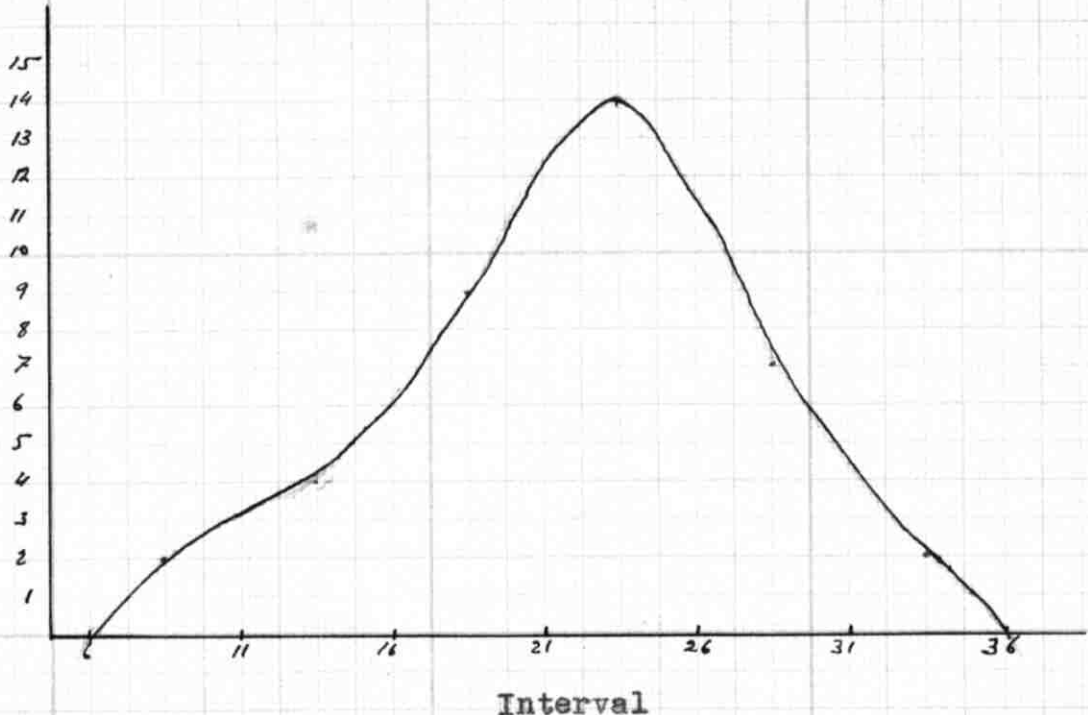
From 12.5% to 25% of the students answered questions 28, 33, 35. This shows us how much our students are weak in laboratory work, in reasoning and in understanding the nature of compounds which they studied.

From 2.5% to 12.5% of the students answered questions 22, 23, 24, 25, 27, 29, 30, 31, 32, 34, 36, 37. Studying the nature of these questions shows us that most of our pupils are weak in scientific reasoning and in solving problems and in understanding the nature of each compound and its function. Only 5% of the students answered questions related to laboratory

work such as questions 27, 28, 29.

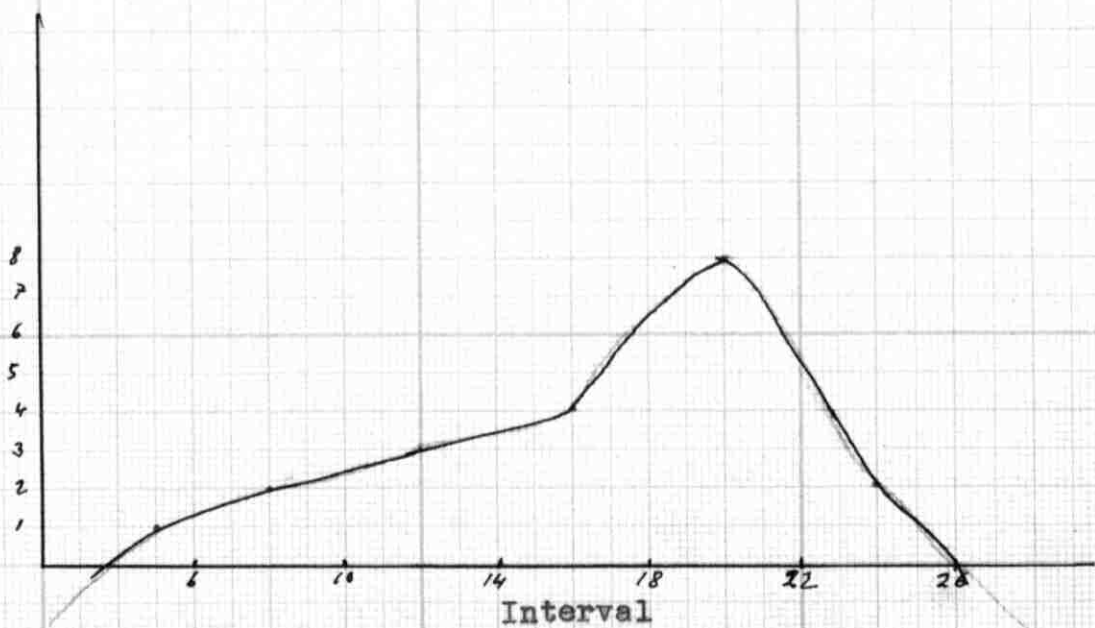
In the following pages are the frequency distribution curves of other pupils in Aleppo, which may give us an idea about the level of the students. The full score is 67.

Frequency

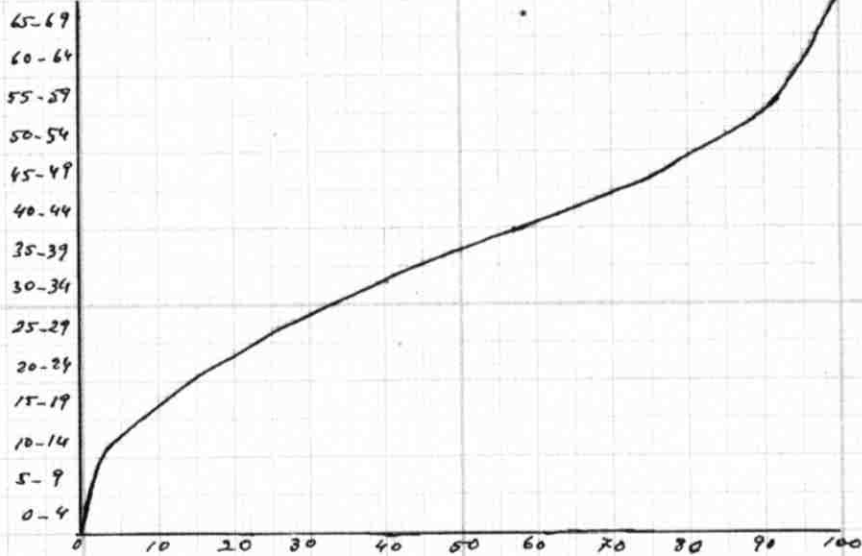


"Frequency distribution curve for the sixth year science (boys) who studied chemistry for three years and left it for six months".

Frequency



"Frequency distribution curve for the sixth year science (girls) who studied chemistry for three years and left it for six months".



Percentile graph for group of American pupils studied
 (one year - nine to ten months)

Comparison between the result of our students and that
of American pupils on the same test.

Comparing this percentile graph with graph No. 1 shows
the difference.

A student here making a score of 46 exceeds 75% of students.

" " " " " " " " 36 " 50% " "

" " " " " " " " 26 " 25% " "

The result of our Syrian pupils is as follows:

A student making a score of 29.5% exceeds 75% of students
" " " " " " 24.8% " 50% " "
" " " " " " 22.5% " 25% " "

On the whole, the achievement of the Syrian pupils is much lower although they studied chemistry for a longer period.

CHAPTER IV

BETTER WAYS OF SCIENCE TEACHING

After this exposition and brief criticism of our Syrian secondary school as far as the teaching of science in general and the teaching of chemistry in particular are concerned, it is time now to turn to the positive and constructive side of our task, namely to expose how the teaching of science should proceed, what basic principles it should be built upon, and what measures we should take in order to change our old fashioned methods of teaching into modern and effective ones.

This of course will be more meaningful if we begin our discussion by noting some essentials concerning the psychology of learning in general and of learning science in particular.

I

WHAT SHOULD BE THE AIMS AND OBJECTIVES OF SCIENCE TEACHING

Why do we teach science in secondary schools and what are its aims ? This is one of the major problems which has been raised by many educators and has been studied by special committees. This should be reasonably clear in the mind of each teacher, because by knowing the objectives of any lesson the aim of education may be more understandable to the average teacher and may be made

to function to a greater degree in the daily orientation of pupils in the classroom.

The objectives in the science teaching may be classified into categories which are different in scope. Each of them is to modify behavior patterns of the individual in such a way as to make his adjustment to the problems of living more effective and more satisfactory.

The National Society for the Study of Education in the 46th Year Book, attempted to express the objectives of science teaching. Here are these objectives summarized as follows:

- 1 - Providing opportunities for the growth in the functional understanding of facts such as:

The nature of matter - elements - compounds - mixtures - chemical changes .

- 2 - Providing development of functional concepts, such as all matter is probably electrical in structure.
- 3 - Providing for growth in the functional understanding of principles such as energy can be changed from one form to another.
- 4 - Providing opportunities for growth in basic instrumental skills such as reading science content with understanding, performing simple manipulatory activities with science equipment.
- 5 - Providing opportunities for growth of skill in the use of the elements of the scientific method.
- 6 - Providing for growth in the development of interests,

interest in some phase of science as a recreational and activity or hobby.⁽¹⁾

If we examine these objectives we can see very clearly that they coincide with the objectives of education, and taken at their best they are in line with what Dewey considers education to be, namely, a "process of growth". These objectives emphasize this idea and bridge very clearly that traditional gap which used to separate the school from life.

Ralph K. Watkin's list has almost the same objectives with special emphasis on training in the scientific method, which when transferred to life means a well balanced personality and free and unbiased mind. His list of objectives of general science runs as follows:

- "1. An understanding and control of environment.
2. A fund of information concerning nature and science.
3. A preparation for later science courses.
4. A training in the scientific method.
5. A development of power of interpretation and application.
6. A development of interest in science.
7. Culture." (2)

What is really peculiar in Watkin's objectives is his seventh one, namely, "Culture". Culture is to be acquired through science as well as through the humanities and social sciences. This, in fact,

(1) The 46th Year Book, of The National Society for the Study of Education. Distributed by the University of Chicago Press, Chicago 37, Illinois 1947, pp.28-29.

(2) Elewood D. Heiss, Ellsworth S. Obourn, Charles W. Hoffman, "Modern Science Teaching", The MacMillan Company, New York, 1950. p. 23.

is what is lacking most in our present system of education in Syria and perhaps in the Near East in general. There is no doubt that our modern culture is built upon science primarily. And to understand well the modern civilization and culture it is imperative to make a good acquaintance with science and to gain a scientific, objective outlook.

After this exposition of science objectives as given by the National Society for the Study of Education and Watkins, we can see that they come to a general agreement about the objectives of science. If we compare now these objectives with those given by Noll in his book, "The Teaching of Science in the Elementary and Secondary Schools", and Cureton in his book, "The Aim and Content of Study in General Science for the Junior High School", and Heiss in his book "Modern Science Teaching", we can see that all objectives mentioned are within the same scopes which I have presented. All of them relate to directions of growth and take an enlarged meaning, and there is an ever-widening and development pattern of relationships among them. They are concerned with the following aspects:- Acquisition of knowledge, abilities, skills, habits, attitudes, appreciations, and interests. It is quite logical now to discuss briefly each one of these general objectives which have been agreed upon with different degrees of emphasis upon each, and which we need badly in our Syrian Schools.

A - Knowledge -

- 1 - Knowledge of the facts, principles and applications of Science.
- 2 - Knowledge which will produce a better understanding of

nature and the organization of our environment.

- 3 - Knowledge which acquaints the pupil with science and helps him to orient himself with respect to the different sciences. (1)
- 4 - Knowledge necessary to correct superstition and erroneous belief. How badly we need such a knowledge in this part of the world.
- 5 - Knowledge which helps pupils for further work in science and for college and university entrance. The reader is warned not to think at all that our aims of education or of science teaching in particular is the preparation for college and university entrance. This is the anti-thesis of the writer's educational creed. Entrance to university is never an aim by itself; it should be taken into account to the extent that it facilitates growth and encourages further development of the living, willing and free individual. The ultimate aim is always growth within society and through sharing in social enterprises.
- 6 - knowledge which will function to serve the objectives stated in the bulletin on cardinal principles of secondary education which are : health, command of fundamental processes, citizenship, worthy home membership, vocation,

(1) Actually I believe with George W. Hartman that science is one, although it investigates different areas; it is for the sake of convenience that we admit the existence of different sciences rather than one science.

See the "Psychology of learning" 41st Year Book of the National Society for the Study of Education." Part II, 1942, p. 173

worthey use of leisure, development of ethical character,
To sum up we can say that the learner should acquire these
types of knowledge because they help him grow continuously.

Knowledge however, is closely related to ability. The
abilities we have to help students to acquire are:-

B. Abilities:-

- 1 - The ability to go ahead - to self direction, the ability to see problems and go ahead and solve them without external stimulus or guidance.
- 2 - The ability to use the scientific method of investigation; to sense a problem, define it, study the situation for all relevant facts, make the best tentative explanations or hypotheses, select the most likely hypotheses, test them by experiment or other means, accept tentatively or reject them or test others and draw conclusion.
- 3 - Ability to pick ^{the} false from the true, to cast away prejudices and be ruled by reason to make pupils able to let the intellect replace the emotion in influencing their decisions.
- 4 - Ability to present ideas clearly and convincingly.
- 5 - Ability to do household tasks such as removing stains from clothing.
- 6 - Ability to use science in the effective use or operation of goods and services.
- 7 - Ability to apply eritical thinking.
- 8 - The ability to apply skillfully the principles, generalizations and fundamental facts in ~~xi~~ new situations which arise in the pupil's daily life.

C. Skills:-

Some instrumental skills are also essential to effective work in science at any level in secondary schools. There are some determined by Watkins. (1)

1 - Locating source materials

- a. Using various parts of a book.
- b. Using materials other than text books, such as encyclopedias, handbooks, dictionaries, etc.

2 - Using source materials

- a. Using aids in comprehending materials read.
- b. Interpreting graphic materials.

3 - Solving mathematical problems necessary in obtaining pertinent data.

4 - Using talks and interviews as source of information.

5 - Making observations suitable for solving a problem.

- a. Devising suitable demonstrations.
- b. Observing demonstrations.

D. Habits:- Man, it has been said, is a sum total of different habits. To this statement I believe that the word "dynamic" should be added. Even habits which are characterized by some rigidity are never static; they are also controlled by the laws of dynamics. I do not believe in that sort of blind habit which is only mechanical, with no understanding whatsoever. Perhaps this kind of habit the French Educator, Rousseau, had in mind when he said, "The best

(1) R. K. Watkins, "National Society for the Study of Education" 46th Year Book, Distributed by the University of Chicago Press, Chicago 37, Illinois 1947 pp. 143-144.

habit is not to have any habit." We do not believe in those habits which subjugate the individual and restrict his freedom or hinder his growth. We rather believe in those reasoned and understandable habits which by saving time and energy will help the process of growth and push it forward. Some of these habits which every Syrian teacher has to establish are:

- 1 - Careful observation of significant facts and phenomena, using hands, eyes, and ears before consulting books.
- 2 - Habit of recording results when the work is done.
- 3 - Habit of work and study including accuracy, thoroughness, persistence, good organization or planning, and neatness.
- 4 - Habit of thinking that contributes to the scientific attitudes.
- 5 - The Habit of suspended judgment, and criticism.
- 6 - The habit of punctuality in attendance and in preparation of work in class and laboratory.

E. Attitudes :- Scientific attitude is perhaps one of the most important things lacking in both our societies and our schools in this part of the world. We are usually, superstitious, fanatic, biased and prejudiced in almost all our social, national, racial, religious and cultural outlooks. It is to be greatly hoped that through acquiring scientific attitudes our mind will be much more liberal and our growth in full accelerated. The following are some of the scientific attitudes which pupils will tend to acquire through the study of science:

- 1 - Accuracy in all operations including calculation, observations, and reports.

- 2 - Holding conclusion as tentative until all necessary facts are secured.
- 3 - Intellectual honesty which involves the habit of submerging personal bias and prejudice, and the habit of admitting being in the wrong when proved to be so.
- 4 - Open mindedness which involves a willingness to consider new data, new facts, and unwillingness to accept a solution as final and ultimate.
- 5 - Efficiency or accuracy combined with speed.

F. Appreciation:-

- 1 - Appreciation of the value and importance of science as it affects pupil's daily life.
- 2 - Appreciation of cause and effect relationship.
- 3 - Appreciation of the value of science to society and to the individual. Science should strive always to realize the welfare of both.
- 4 - Appreciation of the place of man in science.

G. Interest:- Life without interests is unbearable. Interests, however, can be created and cultivated. The following are important and every Syrian teacher should take them into consideration:

- 1 - Interest in the value, worth, and beauty of science.
- 2 - Interest in some phase of science as recreational activity or a hobby.
- 3 - Interest in science as a field for a vocation.
- 4 - Interest in the social and industrial application of scientific principles and the work of research investigations

Our science teaching in Syria should be so carefully organized as to be able to help the learner acquire the above listed recommendations necessary for our scientific Renaissance and consequently for our progress. It is our belief that science in the broad sense of the word, and progress are synonymous.

Specific Aims: So far we have been discussing the aims of science in general. It is perhaps useful for the classroom teacher if the specific aims of each of the branches of science are mentioned. This is only a categorical view point bearing no contradiction to the aims we have just mentioned. We repeat that we conceive science to be one and it is only for the sake of classification and simplicity that we admit such separation among the branches of science. Let us mention here that by science we primarily mean experimental science and more particularly, physics, chemistry, biology, physiology, geology, etc. We are going to content ourselves, however, with general science, physics, chemistry, and biology, for these are the main branches taught in our secondary schools in Syria. The following are some aims:

Aim of General Science:-

- 1 - To give students of the lower years of high schools the information which is fundamental of the special sciences, and to train the pupils' mind in thinking which is necessary for the successful pursuit of science later on and for the understanding and interpretation of simple natural phenomena.
- 2 - To give the pupils an attractive view of the elements of all the sciences.

3 - To show the students something of the relations of the sciences to one another, of the order and unity that exists in nature.

Let us keep in mind here that this stage of contact with science is very delicate. The intelligent teacher should do his best to make the student have a sympathetic attitude toward science and to establish a good rapport with science teachers. It is an unfortunate fact in Syria that there is no such rapport between students and teachers in general and between students and science teachers in particular. The reader, I guess, can easily see the gravity of such a situation. He can recall also, perhaps more than one instance in which the dislike of a teacher has led to the dislike of the matter he taught and vice-versa. The alert teacher, and especially in this stage, will strive to make his pupils interested in his courses and consequently to feel friendly toward him. Mere observation will be able to show how big the transfer is from the teacher to the course he teaches and from the course to the teacher. The able teacher is that who controls both starting points.

Now if this is true in the first contact with science, it is also true in the following stages and all through the school life. Teaching is a stimulus Says Reader, and learning the response; therefore, the function of the science teacher, adds Reader, is to provide the best stimuli in order that the best learning may take place. (1) But can a disliked teacher do so successfully?

(1) Reader, W. G., "A First Course in Education", MacMillan Company 1943

Aims of Biology:-

There are some aims proposed by Twiss. (1)

- 1 - "To give the pupils information of such biological facts and principles as may be most directly and obviously related to human welfare and to right living.
- 2 - To give them training in method of gaining for themselves information in this field of knowledge.
- 3 - To give them opportunity to get an elementary grasp of a few of the great biological principles and the method of organizing biological knowledge.
- 4 - To arouse in them an abiding interest in plants and animals for the sake of pleasure and intellectual profit and culture that such an interest offers for the employment of leisure out of doors."

The writer still remembers how her principal once criticized her preparation of an organized collection of flowers and insects to be used as teaching aids and as means to arouse the girls' interest in the course. The principal described the work as a hindrance for the girls to pass their certificate examinations. Thus the whole criterion by which a teacher's success is measured is to the number of her students who pass examinations, with the implication that the aim of education is passing these stupid formal examinations. This shows us that the reform of science teaching in Syria is impossible and will remain so, as long as it restricts itself to curricula and

(1) George R. Twiss, "Principles of Science Teaching", p.213.
New York, The MacMillan Company 1938.

books. It should rather expand to include preparation of teachers and open minded principals, as well as a deep change in the examination system and in the applied aims of science and education in general.

It is worthwhile to mention here how this movement of preparation for examination is strong. Even the students' health is sacrificed for bookish examinations. A simple glance at our student body will be enough to show how badly our future citizens will be. I doubt whether the neglect of the students' health for the sake of examinations is even justifiable on any ground. But this is a fact under the prevailing conditions in Syria with poor teachers, overloaded curricula, actual system of examination, and inadequate nutrition. The expected reform is not one sided as the reader might have observed.

Aims of Teaching Chemistry:-

Frank said every chemistry teacher should try to develop in the pupils :

- 1 - "A desire for further study in chemistry - when the pupil has real ability.
- 2 - A desire to do something to hasten human progress, to add to the store of human knowledge.
- 3 - A desire to win the reward of his fellows by carrying out some worthwhile projects, even if it involves self sacrifice and lack of material reward.
- 4 - A belief in his own ability, a confidence that his own efforts when worthy will always be rewarded in the end." (1)

(1) J. O Frank, "The Teaching of High School Chemistry" Published by J. O . Frank and Sons. Oskash. Wis, 1932, p. 41.

I think it is necessary also to show students to a certain extent how chemistry is related for instance to medicine which is concerned with the preservation of life, and to agriculture for appreciating the vital importance of the inter-relation of crops and soil and human welfare.

It is stated that "Chemistry teaching should clarify the relation of chemistry to health, vocational pursuits, and to other aspects of living to which the subject matter of chemistry relates and to which it contributes understandingly."⁽¹⁾ This is quite true. Our students should be led to see the importance of chemistry in every day life and in the present civilization. This is more imperative when we believe that besides trying to improve our agriculture we must industrialize our country. This is the way to preserve the rest of our wealth and to increase it and consequently to raise our standard of living which is unreasonably low. By such means we can gain our independence and our self-esteem; otherwise we shall remain parasites and ultimately have no place in the productive world. It is my belief that our salvation is mainly through science and especially through applied science.

Objectives of High School Physics:-

Pupils in high school physics courses should develop better understanding of, and abilities to use, those fundamental concepts and major generalizations of physics that will enable them to interpret natural phenomena, such as matter and energy cannot be

(1) National Society for the Study of Education. 46th Year Book. p. 199. Distributed by the University of Chicago Press, Chicago 37, Illinois 1947.

created or destroyed, but may be changed from one form to another. Common applications of physical principles in industry and other fields, such as the electric lamp, electric lighting system, the camera and the human eye, should be developed.

Pupils in high school physics classes should learn to use the processes of reflective thinking and problem-solving which are best adapted to the solution of problems within the field of physics.

Pupils in secondary schools taking physics should develop those attitudes toward the facts and principles of physics and toward the method of investigation employed in the field which will serve as guides in their use of physics materials and method of problem-solving.⁽¹⁾ Thus we can conclude that although each branch of science has its own aims or sub-aims, all the branches share the same fundamental aim that of understanding nature and gaining control over it, and also freeing the mind to perceive further and greater truths which are presumed to be beneficial to both the individual and society. The task of science instruction is not to discover scientists but it is mainly to ~~make~~ make general use of scientific facts in the daily life. It is in this connection that the following statement was made in the 46th Year Book: "The task of science instruction is then, a much larger one than discovering children of experimental ability in science and starting them on their way to becoming

(1) More development can be found in R. K. Watkins' "National Society for the Study of Education: 31st Year Book, Part I. PP. 250-252. Public School Publishing Company, Bloomington, Illinois, 1932.

scientists, for in a democratic form of government public education involves consideration of the potential contribution of science to all people. The task involves primarily education for all pupils, for their own and society's benefits and only incidentally involves concern for the welfare or future of science."⁽¹⁾ Thus the new trend in education is no more in line with the old concept "Arts for the Arts sake and science for the science's sake ". Everything should be for the benefit of individuals who are growing in society as Dewey advocates.

(1) National Society for the Study of Education. 46th Year Book. page 61. Distributed by the University of Chicago Press, Chicago 37, Illinois.

II

PSYCHOLOGY OF SCIENCE TEACHING

Teaching has been defined as the "act of helping someone to learn, that is, of helping him to acquire knowledge, attitudes, ideals, habits, or some other type of learning which he did not previously possess."⁽¹⁾ Let us add here that the learner's behavior should consequently be modified and improved, because learning has been defined as "the modification of behavior"⁽²⁾ and unless it has this effect on the learner's behavior, it remains ineffective. Teaching, however, can be successful and the best learning takes place, if the teacher understands :

- 1 - The factors which condition learning,
- 2 - The principles of learning,
- 3 - How pupils learn.

and applies these in teaching. Let us now examine briefly each of these items:

1 - Factors which condition learning: These factors are many perhaps the most important are, the psychological, the physiological and the environmental factors.

- (a) The psychological factors :- The chief among these factors is motivation because it is an essential condition of learning. It is the initial step which urges the learner to move towards his goal. Motivation takes

(1) Reader, W. G. "A First Course in Education. MacMillan Company, New York, 1943.

(2) Arthur I. Gates, Arthur T. Jessild, T. R. McConnell, and Robert C. Challman, "Educational Psychology", 3rd Edition, the MacMillan Company, New York, 1949, P. 288.

place in arousing the need, the interest and other motives of the pupil. When the science teacher knows how to arouse these motives he can direct his lesson easily to the desirable goals and at the same time he can lead them to greater activities. The pupil works in an effective way only when he is interested. He learns to observe if he wants to observe for a purpose of his own. He learns to draw conclusions when he feels the need to bring about a desired result. He learns to test conclusions in testing his own ideas to know the truth about his problem. When the pupil really becomes interested, the learning that takes place provides its own thrill, provides motivation for further effort and becomes the origin of new interest. One school of psychology (Configurationism) goes even further and believes in the possibility of creating intelligence. Wheeler and Perkins, for instance, suggest that through effective motivation, education does more than permit intelligence to function, that it creates intelligence (1). The problem which arises here is "How to provoke this motivation". Educators however, agree upon the following as efficient ways to arouse motivation:

- (a) by starting with the pupil's experiences,
- (b) by making him participate in class activities,
- (c) by making the goal of the lesson clear in the mind of the pupil,
- (d) by discussing subjects related to the pupil's interests,
- (e) by providing problematic situations,

(1) Wheeler, R. H. and Perkins F. T. "Principles of Mental Development", The Thomas Y. Crowell Company, New York 1932, P.166.

- f - by using reasonable ways in competition, and especially establishing competition between what the individual's achievement was and what it is at present and will be in the future--self competition,
- g - by keeping the pupil informed of his results; the knowledge of his progress serves as an incentive to him. The influence is greatest when his knowledge of results follows his work immediately.

Davis has recommended many principles which should be observed in informing pupils of their progress. Here are some of them:

"Test results are more effective when they reveal the learner's performance analytically as well as compositely. Compressing the results of a test into a single score or mark has some value. But it is more stimulating if the learner knows the parts of the subject matter in which he is proficient and those in which he has further opportunity to improve. The results are even more meaningful if his performance is analyzed by test items in detail. The learner also benefits if his tests are analyzed with reference to the types of ability demonstrated. Knowledge of his achievement will be more significant, for example, if he knows that also his mastery of specific facts is inadequate, his treatment of major concepts involving reasoning is of good quality."

"The results are more effective when they reveal performance in terms of individual as well as group progress. In many cases a pupil makes improvement that is conspicuous in terms of

his individual ability and preparation. Superiority in a special ability may deserve mention in order to inform him that he has some basis for prestige. His improvement may suggest that he has made actual gain in certain abilities in which he was deficient, even though his total score still places him in approximately the same class rank. He may do exceptionally well in some aspects of a test but as a slow learner he may be unable to achieve the same amount of performance during a test as other pupils. But if he makes any noteworthy gain over his previous record, it should be recognized. Recognition of one's success in learning may overcome the effect of several instances of failure."⁽¹⁾

(b) The physiological factors:- It has been stated by many physiologists that knowledge is based on sense perception. Learning, therefore, is dependent on the condition of the senses and the general tone of the individual. Therefore, the intelligent teacher should pay enough attention to the general health of his students and especially to their senses. Whenever these senses are sane and healthy this means that the way is paved before knowledge to reach the student's mind. It has been known for a long time and was expressed by Locke, Rousseau, Pestalozzi, and Froebel that the impression of the external world comes through the sense. Hence these senses should be cared for and educated so carefully that they would not distort the external facts which are the major task of the physical science.

(1) Davis, R. A. "Educational Psychology", Magraw-Hill Book Company, New York, 1948, pp. 317-318.

(c) The Environmental Factors:- The psychological, social and physical atmosphere influences learning. The gay and lively atmosphere of the class makes students alive and alert. Good Social environment forms as Dewey said: "The mental and emotional disposition of behavior in individuals by engaging them in activities that arouse and strengthen certain impulses that have certain purposes, and entail certain consequences."⁽¹⁾ Therefore, the function of the school is to "eliminate, so far as possible, the unworthy feature of the existing environment from influence upon mental habitudes. It establishes a purified medium of action."⁽²⁾ This is a very interesting and meaningful idea because, as we know, the environment has its own share in the development of intelligence which is the basic factor in the whole process of learning. Intelligence as it has been proved is the product of both heredity and environment. Since we can control the environment more than we can control heredity, it has become imperative to any teacher to strive as much as he can in order to make the students' environment more thrilling, effective, and suggestive. We mean by environment not that ^{of} the school only but also that of the home. This leads us to the relationship which should exist between the parents and the teacher or in general between life and school. The condition of light, ventilation and other necessary comforts have to be taken into account also. These problems are of the utmost importance

(1) Dewey, "Democracy of Education", New York. The Macmillan Company 1950. P. 19.

(2) *ibid.* p.24.

and deserve much attention, but our limited task does not allow us to go into more detail.

Now we have to go back to our second item, which the teacher should understand, namely principles of learning.

2. Principles of Learning:-

The principles of learning cannot be classified as constant and final laws. Nevertheless, there are some laws which are presumed by some psychologists to state the fundamental conditions under which learning takes place:

The following are some of these principles which were formulated by Thorndike in 1913.

(a) Law of readiness : According to this law the pupil must be ready to learn before he can learn. The teacher should create the appropriate environment for creating satisfaction and diminishing annoyance. Thus before beginning our teaching process or our lesson, we should set the minds of our pupils and get their attention and interest in the subject to be taught, otherwise their attention will be somewhere else and the outcome of our teaching will be meager. The ideal application of this law will be perhaps to put the pupils in such a problematic situation as to make them feel anxious to get the solution. Thus the outcome is greater and the development of personality as a whole which is most often neglected is provided for.

(b) Law of exercise:- This law states that exercise strengthens learning and makes it perfect. Learning is propor-

tional to the frequency of different kinds of exercises. This law has a great deal of truth in it. Nevertheless, we should always keep in mind that nothing will take the place of the good understanding and the deep comprehension of things learned. No possible transfer of learning takes place no matter how much the amount of exercises is, unless deep understanding occurs. Exercise is necessary for the acquisition of abilities, but the aim of teaching is much more than the acquisition of mere abilities. Understanding and general applicable conclusions are a major task of the learning process.

(c) Law of Effect According to this law satisfactory results strengthen the bond between situations and responses in most cases. Thorndike believes that the more satisfactory the effects are the stronger these bonds become. We cannot be concerned here with the evaluation of this law from a psychological point of view. Our main concern is in the educational applications. This law implies that the effect of any item learned should be very immediate. It implies also that the teacher should try to make these effects as satisfactory as possible. The personality of the learner should be respected and his abilities should be taken into account so as to offer him the materials according to his mental and psychological levels. The intelligent teacher, however, will make great use of these laws and will provide, for their shortcomings, if they have any. Our third item is How a pupil learns ?

3. How a Pupil Learns :

A pupil usually learns in rather definite steps. When a problem comes to his attention for the first time he usually gets an idea but it is in a block and as a whole. A later contact with it makes it clearer and better understood. This is what is usually meant by the process of "differentiation"⁽¹⁾ or "individuation" as Wheeler calls it. When the pupil finds the opportunity to deal with his problem, he assembles its parts and places them in their true relationship. He may be able to explain it better and understand the principles on which it is based. When the pupil can apply what he gets in new situations and becomes skillful in the use of the principles deduced by him, learning is accomplished. Thus we can see clearly now that learning follows the general principle of growth, that is, it proceeds from the indifferentiated whole to the differentiated, then to the integration. Therefore, we should look at the process of learning just as John Dewey does as being a "process of growth". This has, actually, a very important educational implication. The teacher should not begin with the independent items of his lesson. He should rather begin with the whole idea of what he is going to do, then lead his students through a process of individuation to know the different parts always in relation to each other. Thus they get a further insight into what they learn

(1) R. W. Frederick, G. E. Ragsdale, Rachel Salisbury,
"Directing Learning". D. Appleton - Century Company, Inc.
New York, 1938, p. 39.

and they will be able to do a greater amount of transfer; in other words, they will be better enabled to find more applications of what they have learned. This is much more true in the teaching of science.

III The Content

After the aims of teaching secondary school science have been determined, the next step is to build up the courses in accordance with the aims, and to differentiate the content of these courses according to the need of the pupils.

For building these courses a knowledge of the techniques of the following aspects is necessary.

1- Principles for guidance in the selection of content for science.

2- Organization of content.

3- What should determine the subject matter used,

4- Who should determine the subject matter.

Let us discuss briefly each of these points.

Principles for Guidance In The selection Of Content For Science.

We have mentioned in the second chapter the shortcomings and the weak points in the Syrian curriculum of science. This inadequacy of the content is, perhaps primarily due to the fact that our curricula in general were trans-planted from France, they were not after our needs and aspirations, therefore it is the writer's belief that the content for science in our country should be revised, made more flexible and reorganized in the light of modern progressive education which is built upon psychologically sound principles. What does all this mean?

This simply means that the content should always be considered as a means to an end; this end is the fuller growth of the learner. Hence, unless the content is flexible and manipulable it will handicap the growth rather than help it. On the other hand, the content should be selected and organized in such a way as to meet the changing needs and dynamic growth of the individual learner. The big problem therefore is that there is a body of knowledge with which the learner should equip himself, and there are also his changing needs which should be satisfactorily met if the full growth is sought. How to reconcile and to compromise these seemingly two opposed points. The writer believes with Dewey that the contradiction is only apparent. When we are convinced deeply that education and growth are identical we find no difficulty in finding the proper solution. Let us try to help and orient the student to satisfy his needs and let us put him in such problematic situations that he will find himself in need of a more or less changing amount of knowledge. Let him realize his interests and learn by doing and let us try always to create newer interests within himself in order to provide him with greater opportunities for growth. It seems that we are stepping into the field of methods, but let us say that unless these ideas are clear in the minds of those who lay down the curriculum, their work will suffer a lot. After consulting **MANY** authorities on this topic, the writer suggests the adoption of the following principles which she believes should guide in the process of selection of the content for science:-

1- Subject matter should be in harmony with the accepted objectives set up for the pupils. It should lead to the development of appropriate scientific attitudes and to the understanding of the scientific method.

2- Content should be selected in terms of specific and general adjustment needs of pupils; for example, students like to know what varnishes silver ware and how the varnish can be removed, what disinfectants and germicides are, what antidotes to use for poison, what solvents to use to remove stains, here the curriculum should provide the possibility of presenting these notions, in other words it should not be rigid but rather flexible.

3- Science content should be utilized as a means to an end. The emphasis should be placed on functional facts, functional concepts and functional principles. Learning should be directed toward the larger principles of science rather than toward isolated facts.

4- It should aid the pupils in the interpretation of the local and world environment; for example, how baking is made, how ordinary glass is made from sand, soda and lime, how leather is made, how rubber is prepared, how paper is made from wood pulp.

5- It should be of use to pupils in their daily living, for example, how to remove the hardness of water, how to polish metal.

6- Content should be selected in terms of the interest of children. It should not be the same for rural students as for the students who live in large cities. Each of these groups needs a different kind of science. True, the fonda-

mentals of plants and animal life, of chemistry and physics etc. are the same no matter what the environment may be, but the problems, illustrations, applications will differ widely.

In a rural district, students should naturally tend to stress topics concerned with agriculture and animal life whilst children in towns may benefit from additional work in physics, mechanics, and engineering. Girls will require domestic science of heat and electricity.

It is very interesting to a pupil from a rural district to study in chemistry : the chemical nature of soils, the growth of plants in soils from which certain constituents are missing, the carbon and nitrogen cycles, the chemical action of bacteria, effect of manures and relation of crops, types of fertilizers necessary in particular cases. And it is useful for girls to study for instance the following units in chemistry:

a- cooking. Carbohydrates. Sugar and starch, the nature of flour, ferments and the action of bacteria, yeast and enzyme action, baking soda and carbon dioxide, milk and its constituents, vitamins and their preservation, jams and jellies.

b- Cleaning: soap and how it is made, hard and soft water, washing soda, ammonia, petroleum, benzine, metal polishes, disinfectants, and the correct types to employ certain cases etc.

But it is ^a mistake to be limited by local consideration for the town pupil may need something of gardening and

country life, and how living in the village requires some knowledge of machinery, chemical substances, electricity and its applications. Indeed the broad treatment of science may inspire the child with ideas for a possible futur career.

7- Content should be appropriate for the ability level of the pupils.

8- Content should encourage the belief in, and the practice of desirable social ideas involving science such as health and sanitation etc..

9- Content should be integrated with the hobbies and leisure time activities of the pupils. It should not only supplement and stimulate existing ability but what is more important. It should guide the pupil in choosing desirable activities such as reading and working outside classroom. The various areas of the school curriculum should therefore, rather aim at a set of objectives that will provide for the individual a flexible and adaptable equipment which may be called upon in the solution of many diverse problems of adjustment.

Twiss summarizes the conditions for the choice of subject matter as follows:-

(1) It must be capable of being made simple enough to be clearly comprehended by the pupil. (2) It must be knowledge that will help in the accomplishment of some worthy purpose. (3) It must have been frequently associated

with the situations in which it is likely to be needed or some part of them when the need for it occurs". (1)

The committee on science teaching of the National Society for the Study of Education proposes criteria for the selection of the junior high school science which are in harmony with the modern philosophy of education. Some of these criteria are:

"..(1) The courses shall consist of a variety of physical and mental activities that shall lead to those knowledges, skills, interests and attitudes essential to desirable and practical adjustments to the environment.

(2) The content of the course shall bear direct significance to life's problems and activities.

(3) The order of difficulty of the learning activities shall be such that pupils through reasonable effort may gain the satisfaction of accomplishment.

(4) The learning activities shall call for experiences with the materials and forces of every day life.

(5) The learning activities shall be of such a nature that pupils may be interested in undertaking them and in carrying them to completion under the motivation of helpful guidance of well-trained teachers.

(6) The activities shall be such that they lead to comprehension of the elementary generalizations of science that have important social implications.

(7) The activities shall include abundant opportunities

(1) George Ransom Twiss "Principles of Science Teaching" New York. The MacMillian Company. 1938, p. 90

to apply the acquired knowledges, skills, and attitudes in life situations.

(8) The activities by their nature and order in difficulty shall afford opportunity for the exercise of the creative abilities of growth and for the joy, romance and adventure that discovery, invention and self production in science afford.

(9) The activities shall be objective enough to be attainable and to make possible the determination or measurement of the attainment desired.

(10) There shall be some activities that afford pupils means of judging and measuring their progress in the more specific learning activities.

(11) Some activities, at least, shall be of such a nature that they may be organized into problems identical with the problems of life.

(12) The activities shall call for direct concrete experiences so far as possible, but vicarious experiences that are educative should not be neglected". (1).

Here it is worthwhile to note that the comparatively new idea which has been brought up by the Committee on science teaching is that expressed in No. 3 and 8. The curriculum should provide gradation of difficulty in materials so that every student can find a fair initiation and something to accomplish and feel the satisfaction of accomplishment.

(1) "National Society for the Study of Education": thirty first Year Book, Part I, Bloomington Illinois, Public School Publishing Co., 1932, p. 208.

It has been truly said that nothing leads to success like success itself. The curriculum should provide opportunities for success of different levels. A good curriculum should be a help to the teacher in order to establish good positive attitudes of students toward the subject matter they deal with, otherwise students will dislike the course from a strong negativistic attitude which may ultimately end by becoming an inferiority complex, and hamper growth and prevent the understanding of the course ⁱⁿ spite of the apparent effort the child might display. This is perhaps the case of many fairly intelligent people who do not succeed in arithmetic, grammar or language for instance.

All these principles, therefore, are to be taken into consideration when selecting the content. Let us also keep in mind that the content should not be ambitious and overloaded; it should rather take into account the abilities and environmental conditions of the learners. This will naturally lead us to the problem of organization of content to which we are turning now.

B- Organization of Content.

Organization of materials is one of the main factors in the effectiveness of learning. It determines whether learning will result in a mere memorizing of facts or in functional understanding of concepts and principles. It determine^s also whether or not pupils can develop desirable attitudes, and whether they grow in the skills of problem solving. For example if the materials are organized on the basis of the logic of science this may lead to the

cold and possibly isolated facts, but organizing subject matter around concrete problems arouses the interests of pupils and gives them the chance to participate in discussion and problem solving, and serves in the development of desirable educational goals.

Print has recommended that "science courses in high schools should be organized around significant and appropriate generalizations which may recur again and again at successive levels". (1) Actually this is what our curricula need more. Unfortunately, they are all organized after logic. And no wonder if they are so, are they not a copy of the French curricula? It has often been said that the French mentality is^a logical one, but what our curricula have to do with that? Let us try to know how our children learn and what the easiest way for that is?. After all what is meant by this "logical"? Is logic an end in itself? According to our philosophy of education, it is not and it should not be but a means to our main postulate and aim which is "growth". It is not consistent with our concept of education to sacrifice growth for the sake of sheer "logical organization". Functional organization is the type we advocated, and only when the "logical" and the "functional" coincide we admit the "logical organization". Perhaps, we should admit the "logical" ~~When~~ we deal

(1) From Victor H. Noll "Teaching of Science in Elementary and Secondary Schools" p. 133. Longmans, Green and Co., New York, London, Toronto, 1942.

with pupils we advocate the functional and psychological organization, and here this organization actually becomes "logical", and otherwise, when the organization neglects the children's level of understanding and ability, it should be fairly called "illogical" rather than "logical". Perhaps Twiss expresses more clearly what we consider as "logical arrangement or organization of curriculum". Here is what he says: " Any system of arrangement for organization is the logical one if it is economical and if the relations under which the parts are grouped are real and close, the best arrangement for the teaching processes is that which is most obviously personally useful to the student and which he can come nearest to making wholly for himself, as the product for his own thought".(1) The problem which may arise here is how to organize the curriculum in order to be consistent with the psychological facts? The answer to this may be found in the following principles which are worthy of consideration. The essence of these principles are suggested also by many authorities on this field. Here are some:

1) Subject matter should be arranged under various headings and subheadings or classified according to the relation that the facts or principles bear to one another.

2) Association plays a very important role in learning and it is, therefore, imperative that material be organized

(1) George Ransom Twiss "Principles of Science Teaching" New-York, the MacMillan Company, 1938, p. 76.

so that patterns of integration emerge as learning proceeds.

3) The sequence of units should be planned to give recurrent contact with facts, concepts, and principles of science and to provide an enlarging pattern of growth in concepts and principles.

4) Problem situations should provide definite training in one or more of the elements of the scientific method.

5) The course in science should be organized to provide frequent opportunity for pupils to participate in planning and to engage in individual and group projects.

The Committee of Science Teaching of The National Society for the Study of Education recommended as guides for the organization of science content for the junior high school these tentative principles:

1) The course should be organized into units, each of which shall be related to some significant aspect of the environment.

2) The unit shall be essentially a major problem of every day life to which science may contribute the intelligent basis for human adjustment.

3) Each unit shall include only a few principles or generalizations of science.

4) Each unit shall be divided into subordinate problems to facilitate learning by pupils.

5) the continuity of the units shall be such that the entire course develops a sequential story of man's understanding of, and adjustment to his whole science environment.

6) The organization in parts at least shall be in the form of problems or projects to insure education in problem solving, which is the nature of science.

7) There shall be relatively few units, in order to insure that pupils are brought to the understanding of the larger relationships of the facts and principles of science rather than to the mere memory of detailed facts.

8) The units shall be so organized that the conceptions of science and their social implications, once learned shall be used in new relationships in later units.

9) The interrelationships of generalizations and their social significance shall be brought to the attention of pupils by abundant cross references and cross exercises.

10) Not only shall generalizations be developed in each unit, but there shall also be abundant opportunities to apply the generalizations in the interpretation of novel problems and novel phenomena.

11) In so far as possible, the units and their study materials shall be arranged and organized in such a way that the succeeding units will call for the understanding of longer and larger relationships and conceptions, will contain progressively difficult activities, and will arrive at more and more comprehensive adjustments.

12) There shall be provided in each unit enough activities to insure accomplishment of the objectives by pupils of different interests and capacities.

13) In general the units and the subordinate problems within each unit shall proceed in line with the scientific methods of problem solving; that is

a) From sense perceptions of materials, forces, or phenomena to the formulation of ideas, to the testing of the hypotheses, to the tentative conclusions, and to the application of the conclusions in life situations.

or b) From principles or generalizations to the interpretation of scientific situations.

14) The distribution of time and emphasis to the various units shall be determined by the total functional, social value of the unit, its teachability and 'learnability', the teacher's and pupil's interest in the unit, the local significance of the unit and its value to other units of the course.

15) The entire set of units shall be so formulated that the pupil will have revealed to him the kinds and nature of the major fields of science.

16) The laboratory work shall be included as an integral part of problem-solving and shall, therefore, have the characteristics of experience getting work rather than of illustrative or confirmatory work.

17) Historical and biographical content shall be introduced when and where it will aid in understanding of the concepts developed and of their social implications and in the attainment of the human adjustment sought.

18) Subject matter shall be so arranged that it will be as means to the solution of problems and not an end in itself.

19) In so far as possible, the materials and activities shall be organized around the pupil's life but shall project the pupil into the problems of adulthood.

20) The organization shall be such that it will lead to attainment of the immediate and ultimate objectives⁽¹⁾.

Thus we can conclude that the organization of the curriculum should be a functional psychological one. It should be organized not in terms of logic of science or dismembered facts, but rather in terms of meaningful units having close relationships to daily life. Furthermore the sequence of units or topics as well as the sequence of material within a topic is determined by the difficulty of the unit, its seasonal relation and its interpretative value.

So much for the organization of content. Let us now turn to the other side of the problem namely: What should we teach our students, or in other words what should determine the subject matter used.

(1) C.J. Peiper "The National Society for the Study of Education" 31st Year Book Part I pp 209-211. Public School Publishing Company, Bloomington, Illinois, 1932.

C- What should Determine The Subject

Matter Used.

This is an important problem about which various suggestions have been presented. The writer, however, after consulting many authoritative works on this subject tends to adopt particularly the points of view of Noll, Frank, and Hoff. They all agree on the following plans as criteria for the selection of the content of science.

1- Study the history of science and evaluate each generalization on basis of the value of its contribution to the progress of civilization and welfare of man.

2- Study the interests of pupils by presenting questionnaires to them.

3- Study the activities of people and analyze them, and build the science curriculum so that it will contribute most to increased efficiency in all these activities.

4- Study the need of high school pupils as shown by what they do when they leave secondary schools.

5- Study the textbooks used in various schools and analyze them to see to what extent "authorities" are agreed as to what ought to be taught.

6- Analyze current literature such as news papers and magazine, and select some major topics for studying (1).

(1) For further details the reader is referred to :-

- a- Victor H. Noll "The Teaching of Science in Elementary and Secondary Schools" pp. 100-114.
- b- Frank "The Teaching of High School Chemistry" pp. 52-55.
- c- Hoff "Science Teaching" pp. 79-87.

Curtis combining the results of four textbooks analysis studies, six analyses of scientific interests, three published reports of analysis of magazines, secured 1800 subject matter topics organized and placed in a table containing these topics. The interested reader may make acquaintance of this result in his work. (1)

D- Who Should Determine The Subject Matter Used:

After representing in the previous parts the different conditions for selecting and organizing the subject matter used, and how it should serve the needs of pupils in varying situations and varying abilities we can imagine the handicaps in selecting the subject matter and how much it is difficult for one whoever he is to do this job. Therefore there should be some special committees composed of specialists, educators, teachers, and supervisors who have experience to do this work. Nevertheless in some communities, like some American ones, even the parents and some business men take part in the task of determining the subject matter. I think there is no harm in that, provided the parents are highly educated and the business men are of good will. This is not to underestimate at all the major role the specialists and educators have. They are supposed to be virtuous,

(1) Curtis F.D. "A Synthesis and Evaluation of Subject Matter Topics in General Science", Also in Curtis "Second Digest of Investigation in the Teaching of Science, p. 68.

broadminded and knowing where the interest of their country lies. Therefore, they have to take the initiation and to play the essential role. As to parents and business men, their participation may be justified on the ground that they might have some beneficial suggestions, and on the other hand, they will be helpful to the school and administration. Francis D. Curtis, a member of National Committee for the Study of Education reported on this point. He does not emphasize the role of parents and business men, but he does stress the cooperation between specialists in the field of science and the educators, "It is the opinion of this Committee" says he, " That neither the University Specialist nor the classroom teacher alone can produce the most effective classroom materials. Authors of textbooks and syllabi should take into consideration the point of view of three groups: (1) subject matter specialists who insure that the materials are accurate and up-to-date. (2) classroom teachers and supervisors who refine the materials in the light of their appropriateness of content and difficulty and (3) specialists in the teaching of science who contribute a knowledge of development in the field with respect to educational research". (1).

(1) The National Society for the Study of Education" 31st Year Book, Part I, p. 110. Public School Publishing Company, Bloomington, Illinois, 1932.

By this way the subject matter will be suitable for special students in special environment, and will be nearer to their life and meaningful to them, much more than subject matter prescribed by a person who obtains it from different syllabi.

IV -

The Method of Science Teaching

No matter how the curriculum is adequately selected and excellently organized, if it is put in the hands of a poor teacher, the teaching outcome will suffer. It has been a known fact that the best curriculum in the hand of the untrained teacher is much more inferior to a poor curriculum put in the hand of a well prepared teacher. There is always this adaptation of the workman to his tool. The alert and good teacher will compensate more or less for the weaknesses or shortcomings of the curriculum. Teaching may be considered as an art. That is why the method is of prime importance in teaching. The method used in teaching in general and in science teaching in particular distinguishes a good teacher from a poor one. The method used in science teaching is the only way by which the teacher can realize the major goals of education and of science teaching.

"A recent conference of secondary modern science teachers is reported in September issue of the Bulletin of the University of Nottingham Institute of Education. It is pointed out that there is no general agreement about the body of knowledge to be taught; what is wanted it is suggested, is not a "common core" of subject matter in science so much as a common aim. The most generally accepted aim in science teaching is embodied in the remarks of ^{the} teacher who said "subject matter is not important so long as the child is equipped with a method of thinking which he can apply in fields other than those in which he has acquired it". Much the same point was expressed differently by

another teacher who said: "The important thing is the attitude adopted by the child to science, for in a few years, he will forget the actual information imported but will remember the personal attitude of the teacher and the principles he has taught" (1). By method the teacher directs the subject matter to desired results and can develop desirable habits and attitudes. It is not the facts themselves which make science but the method by which they are dealt with. The method being so important, it is worth while to consider the educational bases of science teaching method in particular."

1- The Educational basis of Science Teaching Method.

Science is mostly an experimental body of knowledge. The true spirit of it is discovery; therefore, it cannot be learned by memorizing the principle first and by applying it to exercises afterwards. A good method will provide situations in the form of a challenge to pupil's curiosity. This may be through questions, demonstrations, suggestions and experiments. Problematic situation^s should be thought of and provided in such a way that they should allow the pupil or rather compel him to analyze, compare, abstract, and draw conclusions according to the scientific

(1) From a correspondent "Science in Modern Schools". "The Times Educational Supplement" Friday, January 12, 1951, p. 25.

method of thinking. The pupil has to be put in the position of an original investigator; he should be guided to discover the principles for himself. Thus the importance of the method in science teaching is obvious. Dewey goes further to say that by the "methods ----- the subject matter of our ordinary activities is transmitted into scientific form"(1). He adds also that by " the method ----- alone, science is science".(2)

Before proceeding further and discussing some methods used in science teaching I would like to call the reader's attention to a point ^{which is consider of great importance . when we look} at the civilized world around us, we really admire what science has done and some of us even base many good hopes upon it. On the other hand, let us look at the student's attitude toward science courses and specifically in our Syrian Schools. What do we usually see? One often sees that the students are not so enthusiastic toward science as they are toward arts, for instance. Why? Is that because of any repulsive force inherent in science itself? Why is it admired outside the courses and not liked in them? To these questions, Dewey answers quite pertinently by saying that the method of teaching science is primarily responsible for that. When science is taught in such a way as to be of no "fruitful contact with every day experiences", the student will not be interested in science. And furthermore "material so taught is not science to the pupil" (3). Although it might be science

(1) John Dewey "Democracy and Education" Op Cit p. 258.

(2) Ibid pp. 258 - 259.

(3) Op Cit p. 259.

to the scientist. Unfortunately this is, exactly, the case in our Syrian Schools. Let us hurry to mention here that this does not apply to science teaching only, but to the teaching process in general. Our schools by their methods and curricula are still far from life. How are we to teach science therefore? How are we to make it attractive to the students in the school, and can we so change our life as to build it upon sound scientific principles? These are the questions whose answers will have great effect upon our scientific make-up. But before answering these questions, I would like to expose here how Dewey conceives of science. This perhaps will throw some light upon the discussion. Science according to Dewey is "that knowledge which is the outcome of methods of observation, reflection, and testing which are deliberately adopted to secure a settled assured subject matter. It involves an intelligent and persistent endeavor to revise current beliefs so as to weed out what is erroneous, to add to their accuracy, and above all, to give them such shape that the dependencies of the various facts upon one another may be as obvious as possible. It is, like all knowledge, an outcome of activity bringing about certain changes in the environment." (1) In science there is observation, reflection, testing and changing of the environment. This implies that our method in teaching should aim at all these, but in terms of pupils', and not ~~another's~~ or teachers' activities. "From the stand point of the learner", says Dewey, "scientific form is an ideal

(1) John Dewey "Democracy and Education", The Macmillian company, the 23 rd printing New York 1950, p. 256.

to be achieved, not a starting point from which to set out" (1). This is to say that the pure logical organization of the curriculum and the application of the pure logical method in science teaching is not psychologically sound. It is not reasonable at all to make the student begin at what just the scientist has ended. Unfortunately a great majority of our textbooks are logically and not psychologically organized and the majority of our science teachers cling to them slavishly and follow the method used in the textbook itself. It seems that they forget that all the "instructional techniques are (nothing but) aids to the growth of the learner" (2), and that "instructional techniques must be flexible" (3) to suit the class circumstances and individual differences. This is, perhaps, one of the main causes which make our student learn "symbols without the key of their meaning. He acquires a technical body of information without ability to trace its connections with the objects and operations with which he is familiar - often he acquires simply a peculiar vocabulary" (4). Thus the materials learned are not connected with problems of every day life; and consequently, you can easily find a good majority of students who studied science for more than six or seven years and are

(1) Op. Cit. J. Dewey, p. 257.

(2) Elwood D. Heiss, Ellsworth S. Obourn, and Charles W. Haffman, "Modern Science Teaching", the Macmillan Co. New York 1950, p. 80.

(3) Ibid p. 81

(4) John Dewey. "Democracy and Education", 1950, p. 257.

unable to repair an electrical switch or an electrical bell although they can describe them to you quite well theoretically. It is true that the psychological methods need more time but as Dewey says "The apparent loss of time involved is more than made up for by the superior understanding and vital interest secured. What the pupil learns, he at least understands. Moreover, by following, in connection with problems selected from the material of ordinary acquaintance, the method by which scientific men have reached their perfected knowledge, he gains independent power to deal with material within his range, and avoids the mental confusion and intellectual distaste attendant upon studying matter whose meaning is only symbolic. Since the mass of the pupils are never going to become scientific specialists, it is much more important that they should get some insight into what scientific method means than they should copy at long range and second hand the results which scientific men have reached. Pupils will not go so far, perhaps in the "ground covered", but they will be sure and intelligent as far as they go. And it is safe to say that the few who go on to be scientific experts will have a better preparation than if they had been swamped with a large mass of purely technical and symbolically stated information. In fact, those who do become successful men of science are those who by their own power manage to avoid the pitfalls of a traditional scholastic introduction into

it" (1). We may conclude that through good methods used by wise and devoted teachers, science can change our life radically and save us from our superstitiousⁿ and retardation. Science is able to help us take our place in the universe and play our constructive role in the progress of human race.

2. The Influence of Method on the Result of Teaching:-

It has been shown experimentally that some methods have higher value than others; they have better influence on the development of pupil's interest, understanding, and achievement. Nell, for instance, reports some cases in which the method of instruction could compensate for inferiority of intelligence. In one of his studies his subjects were the students of two classes A and B in the ninth grade, general science. Group A had a mean I.Q. of 116 while group B had a mean of 93. The median score on the Duorak test of general science for group A at the beginning of the year was 91.5 while that of group B was 85. In group A the first ten minutes were used for the day's lesson followed by assignment and twenty minutes of directed study, two of five periods per week were used for laboratory chiefly demonstration. Group B was taught according to the following principles:

- a- use a variety of tests
- b- do as much experimentation as possible
- c- follow pupil's interest
- d- pupils select and perform experiments
- e- insist on a list of references for each topic
- f- make pupil feel responsible for the course

g- permit expression of pupil's ideas and originality at any time.

During the first two weeks pupils simply browsed; no assignments were made and pupils did pretty much as they wished. By general open agreement a topic (air) was selected to work on in the third week. The general procedure there after was:-

- a- selection of a topic,
- b- preparation of individual reference lists and combining these for class use,
- c- discussion by individuals of points of interest,
- d- performing experiments and discussion of results,
- e- discussion of related topics.

Pupils were encouraged to bring in supplementary topics and materials. A bulletin board was much used. The pupils wrote reports of laboratory experiments in a form which they collectively devised and which they themselves scored. The teacher tried to guide the work into some organized form. At the end of the first semester both classes took power's general science test. The median score of group A was 48, that of group B was 47. (1). Thus we can see how a good method of teaching may help the student grow and develop.

It is time now to come back to our question to see what is the best method in science teaching; let us see also whether there is only one method for teaching science

(1) For further details see ~~Roll~~ Victor. H. Noll "The Teaching of science In Elementary and Secondary Schools" Chap.IV p.80.

fruitfully. As a matter of fact, many methods have been suggested, well known among them are the lecture method, the lecture demonstration method, the unit problem method or the project method. Let us now describe very briefly each of these methods.

1- The Lecture Method:-

This method is very old and it remained for many years the only method used in science teaching. Unfortunately it is still practically the only one used in many of our secondary schools. The teacher actually is the only active person in the class; he lectures and speaks all the time. This is a fine way for covering ground, but is covering ground the aim of science teaching? Nevertheless, this method has some advantages if modified a little and restricted to summarizing principles, reviewing previous lessons or speaking about scientist's lives. It should never be the only way. Let us add also that illustration, maps and charts, aid pupils in understanding scientific principles and facts. They are more effective than words in producing clear mental images and correct understanding, especially when they are not used as an end in themselves but as a means to clarify the lesson. As Hoff said: "Drawings should be accompanied with detailed explanations as to their interpretation. Diagrams tend to bring out more clearly the scientific aspects which need emphasis. Labelling of prepared sketches is found to be a great time-saver and is considered to be more efficient". (1)

(1) Arthur G. Hoff "Secondary School Science Teaching" Philadelphia, the Blakistan company. Toronto 1947, p.180

2- The Demonstration Method:-

Here also the teacher is the active person, while the students have to watch him do. Nevertheless, if employed in conjunction with the lecture it may very well become an efficient method for ~~sparing~~ time. The lecture - demonstration method may have some advantages if the students can participate in observing, collecting material, discussions and questions. It is useful in the case of an expensive or a dangerous experiment. However, it can never take the place of the laboratory method. It has great advantages with children who are not yet acquainted with laboratories. "At the start of every laboratory course there should be a sufficient use of the demonstration method to acquaint the pupils with apparatus and with accepted methods of experimentation. Following this period of orientation, the pupil should be allowed to perform some excersises individually in order to acquire, early in the course, desirable manipulatory skills and laboratory techniques and habits". (1).

3- The Laboratory Method:-

Used in conjunction with some other techniques it may be an excellent means in observing and collecting evidence for the solution of problems. To be effective and productive, the laboratory method must be planned, directed and controlled by the teacher. But this does not mean

(1) "The National Society for the Study of Education" 46th Year Book Distributed by the University of Chicago press. Chicago 37. Illinois 1947, pp. 53 - 54.

at all that the learner should follow the laboratory directions slavishly and without thought. Otherwise, the laboratory work will degenerate into mere busy work of an insignificant meaning. A "fruitful laboratory work (should) follow a discussion where likely hypotheses for the solution of a problem are proposed and considered. Here the pupils plan cooperatively with the teacher in devising ways of testing a given hypothesis and controlling factors, thus making their own directions".(1). The student, therefore, should come with his problem to the laboratory and not just to do what the teacher asks or the curriculum prescribes. "Good laboratory work must be motivated by the spirit of discovery. It must leave room for pupils to plan procedures, make mistakes, and try various methods until they come out with evidence that can lead to conclusions and the satisfaction of having discovered something new to them".(2). Thus the alert teacher should put the student in well-levelled problematic situations and should make him feel the need for solving them and discovering their secrets. Then the laboratory method will be meaningful. Let us conclude by quoting Glem Blough summarizing the principles that

(1) Elwood D. Heiss, Ellsworth S. Obourn, and Charles W. Haffman "Modern Science Teaching" The MacMillan Co. New York 1950, p 117 - 118.

(2) Ibid p. 164

should be applied in the laboratory method:

- 1) Experiment should be conducted in such a way as to make pupils think.
- 2) Children should be conscious of the purpose for performing an experiment.
- 3) Careful planning is essential to successful experimenting.
- 4) In so far as possible, children themselves should perform the experiments, working as individuals or as groups.
- 5) Many times, children can suggest experiments to answer their own questions.
- 6) Experiment should be performed carefully and exactly.
- 7) Pupils should learn the value of controlled experimentation.
- 8) Simple apparatus is more appropriate for use in experiments in the elementary school (and junior high school) than complicated material.
- 9) Pupils should exercise great caution in drawing conclusions from experiments.
- 10) As many applications to every day life situations and problems as possible should be made from experiments".(1)

4- The Unit-Problem Method:-

This is similar to the previous method and more comprehensive. According to this method, the materials of instruction are stated as broad problems or principles

(1) Op. Cit. pp 164 - 165.

such as :

- a) how do we make soap?
- b) how do we light our homes?

These problems are then broken down into smaller learning problems for purposes of instruction. The first broad problem (a) for instance, may be broken down into the following units:-

- 1- what does soap clean and how?
- 2- what are the constituent elements, how are they combined together, and in what proportion?
- 3- can we make various types of soap?

This method has been proved to be useful and flexible. It may include all the previously discussed methods; thus each method is used where it will produce the most effective learning. This method makes room not only for cooperation among pupils but among teachers and pupils as well. The unit-problem method is not narrowly restricted to science. When the direction of the work falls in the social area, for instance, the social studies teacher directs the work until the unit is covered and the class, acting usually in small groups, feel that they are satisfied with the solution reached. The whole work is not necessarily to be done in the class-room only. It may take place in the library, in the laboratory and through visiting factories or other places. The basic assumptions underlying this method are that science and society are not separable, and the aim of science education as well as that of general education

is one, the full growth of the learner. Let us mention here that such progressive methods can not be applied in our schools unless our curricula are made more flexible, more wisely organized, and unless our examination systems are modified.

After discussing these main methods, let us add that the best method is that which suits the circumstances of the learner first of all, and those of the school secondly. In the final analysis the technique must be made to function by the carrying out of flexible plans by teacher and pupil. "The teacher must constantly remind himself that the end sought is the growth of the pupil and that the learning of content is only one of the means to this all important end".(1).

So much for the methods of science teaching. Let us turn now to the problem of evaluation, for method and evaluation are interdependent.

(1) Op. Cit. p. 126

Evaluation of Learning in Science.

In any teaching-learning situation, knowledge of the results and appraisal of the outcome is necessary. Both the teacher and the learner, like to know the amount they have achieved and the degree to which their goals have been attained. This knowledge will help them in reorienting their efforts and in giving them more self-confidence and courage in the normal situations. Thus further development and progress may be provided for, through reorientation, reorganization and fresher efforts to go ahead and avoid mistakes. The necessity of evaluation is, therefore, established. It is necessary, however, to keep constantly in mind, that evaluation is not an end in itself; it is only a means to our all important end, which is the learner's growth. As a matter of fact, if we bear in mind our philosophy of education centering around the concept of "growth" we cannot go astray nor can we lose touch with educational realities of which evaluation is only one. This, therefore, will determine, more or less the role and qualities of the evaluation instruments. This also implies that our evaluation instruments should not test the sheer amounts of knowledge which our students have obtained. The problem is deeper, for we do believe that learning is not a process of acquiring bits of information, but is rather a modification of behavior. It has become imperative therefore, that our attempt should not aim at evaluating mastery of content but rather at evaluating other out-comes such as aspects of thinking, ways of

acting and depth of desirable attitudes. These outcomes, we believe, are much more important than memorizing what a textbook says. And it is the writer's belief that these outcomes are perhaps the best criteria with which we can distinguish the cultivated and growing mind from that one which is stuffed with dead knowledge. This direction is perhaps more significant as far as science teaching is concerned and particularly in this part of the world where the scientific spirit is still to be sought. It is quite usual here to find among the most successful students who, after studying for so many years, received high academic degrees, individuals thinking in terms of superstitions and primitive metaphysics. The writer still remembers one newly graduating doctor believing in what the laymen call "the evil eye" and "bad luck", and over all in some metaphysical force, other than germs, such as God who makes us sick or feeling well. How can we attribute growth to such individuals? Can we pretend that they have acquired a higher level than those who remained outside of school? Can we assume that they are abler to solve scientifically and wisely their daily life problems? And yet if you rely upon the examinations they passed, you should answer positively, although this is against the observed facts. Examinations therefore, are inadequate if not detrimental. At present, unfortunately, our schools consider examinations as aims and not just a means to discover the strong and the

weak points in the process of growth. It seems that the elementary school prepares the pupil for the "Certificat d'Etudes Primaires", the secondary for the "Brevet" and "Baccalaureat". It seems that our educators have forgotten the true aim of education and have clung to preparation for diplomas as an aim. No wonder, therefore, if we find ourselves living on the margin of life, surrounded by ignorance and superstitions.

So much for the philosophy of examinations. Regarding the way of their administration and of the preparation of tests, the situation is worse. I am afraid this is not the right place to discuss this problem and to show the negativistic attitude the students have against examinations and how these are detrimental to their growth. Let us, therefore, concentrate upon the problem of testing ; and let us hurry to say that, up till now, we have no one single standardized test neither in science nor in the other fields. The tests used for students promotion from one grade to another are all teacher-made tests. As to those used in the official examinations, they are prepared by the Ministry of Education. Here the intelligent reader might have observed that our system is strictly centralized and the environmental conditions are not taken into consideration either in teaching or in testing. The intelligent reader might have deduced also that the tests used in this part of the world lack the properties of diagnosis and prognosis. This is all true; we have not yet been attracted by that movement of test and measurement for the appraisal

of achievement and for the sake of guidance and orientation. It is the work of modern teachers to provide for this, and to compensate for the limitations of paper and pencil tests, the oldest test and the only kind of tests we use. Let us try to supplement these tests in order to make their appraisal of the growth of pupils more reliable. "For, at best, a pencil and paper test can reveal only how a pupil reacts to a situation that is described; there is no assured relationship between this type of behavior and the way he might react to a 'real life' situation". (1) It is useful perhaps to mention here before leaving this topic, some ways of testing the students in science, used in the States to supplement the paper and pencil tests. (2).

These are:

1- Classroom questioning and discussion: This includes:

- a- Oral questioning.
- b- Sensing and defining problems.
- c- Proposing hypotheses.
- d- Determining the facts essential to an explanation.
- e- Applying scientific principles.

2- Observation of significant behavior: This includes:

- a- Informal observation such ^{as} (1) Observing the attitude and flexibility of learner; is the learner able to change his opinion in the light of new and reliable evidence?

(2) An out-of-school use of scientific method. This

(1) Elwood D. Heiss, Ellsworth S. Oberon, and Charles W. Hafman "Modern Science Teaching", The Macmillan company, New York, 1950, p. 198.

(2) The National Society for the Study of Education" the 46th year, Book part I, Science Education in American Schools, 1947, pp. 265-271.

necessarily implies that some kind of rapport should be established between teachers and students, and that there should exist a good relationship between the school and parents. (3) A longtime observation toward science objectives. Perhaps the following story (1) will illustrate this idea. In a class of science, a bright girl became interested in the effects of various amounts of chemical elements in the soil on the growth of plants. Being unable to carry out experimentation in the school laboratory, she visited a local plant - research center, talked with the soil chemist there and with his help she defined her problem. Then she went on selecting plants, sterilizing sand, weighing precisely with chemical balances (for the first time). Her experiments lasted more than six months and finally after many trials, her results were checked with those of a trained worker and found to be reliable. During this long period of time the teacher was observing the girl and her significant behavior changes. No doubt, no paper and pencil test is able to detect in full what this way of observation did. (4) Carry over to the community or within the school; this means that knowledge should not remain theoretical; it should be applied in the daily life. The alert teacher should encourage and observe those who are interested in applying science both in school and community.

b- Systematic Observation:

This is similar to test situations. The teacher may

(1) Op. Cit. p. 268

prearrange situations to observe his student acting in them. Thus he gives the students opportunities to transfer their scientific knowledge from one field to another and from books to actual life.

5- The interview and conference:

This is a more direct way to know the student and help him grow. Through this close contact the alert teacher may encourage the student to talk about his likes and dislikes, his hobbies and interests, his ambitions and plans. The atmosphere here is more friendly and entirely different from that of examination which is usually not liked.

These are only a few ways to supplement the usual paper and pencil tests. They are capable of adaptation to any classroom or laboratory by the good teacher who is interested in measuring growth of his pupils in order to provide more opportunities for further growth.

Before finishing with the problem of education, let us call the reader's attention to the fact that we need some standardized tests with which to measure the growth of our Syrian student. These are useful at least to tell the teacher that his students' achievement is around or below the average. Powers' test with which we dealt in the (3rd chapter) is a good ^{one} for instance, it is adaptable into Arabic. There are many which are adaptable too. We are justified, I think, to hope and work for the fact that it is possible for our Syrian student to be like his classmate in Europe or America as far as science outcome

specifically is concerned. For science is one everywhere and the scientific spirit is universal. However, let us not underestimate the role of the environment and its effect in the fulfilment of our hope. To provide a good and stimulating environment two kinds of conditions are to be cared for :

1. the social political and economic conditions.
2. the instructional conditions.

It is true that the two kinds are ~~conceptual~~ but we are going here to concentrate upon the instructional conditions mainly because of the space limitation. This will be discussed in the following pages and be considered as the conclusion of our study.

CHAPTER V

SUGGESTIONS AND RECOMMENDATIONS FOR THE IMPROVEMENT OF SCIENCE TEACHING IN SYRIAN SECONDARY SCHOOLS

A. Science Teaching is Imperative :- After this more or less exploratory study of science teaching in our schools, it seems fair to stop here and try to make our conclusion in terms of suggestions and recommendations built upon recent investigations and modern concepts of education. Let us begin by recognizing that science education has become imperative nowadays where the whole structure of our civilization is built upon science. Science education is imperative also if we seek a universal security built upon real scientific understanding of human needs and social bond. "If four fifths of the earth's people are illiterate, how can they cooperate in programs for the advancement of society ?" (1) We can also add: If a good part of the earth's people are dominated by imperialistic powers and treated like slaves, how can they be made to cooperate in the universal security and in the advancement of the human race ? The writer shares with Dewey and with many good thinkers of good will the belief that it is only through science that we can realize our humanity and get

(1) "The National Society for the Study of Education" 46th Year Book, Part I. Distributed by the University of Chicago Press Chicago 37. Illinois, 1947, p. 295.

that desired universal security and progress. It is through science and more accurately through science teaching and the scientific method that this aim is attainable. Curtis holds the same idea and says that "The scientific method, like the scientific fact, may be characterized by the objective common. The facts and methods of science are those which may be shared in common by members of the human species. They are not based on the whim of one individual, but conclusions reached by individuals who may be regarded as competent judges in the particular case, and who place similar interpretations upon groupings of sense impression past and present."⁽¹⁾ Science therefore makes for human understanding and human solidarity and better life. Hence we are fully justified to pay enough attention to the improvement of science teaching.

B. Preparation of Science Teachers:- Whenever we mention science teaching, our mind turns toward that creative force which has been put in the hands of science teachers. "The science teacher is the major factor in gaining better opportunities for true leadership... His life is largely with his students and, as he is, so may they become. Real teaching produces its enduring benefits to those taught and to those who teach."⁽²⁾ The Preparation of science teachers, therefore, is of prime importance. And the amount of money that our government should spend regardless of how big it is, for the preparation of good science teachers, is no more consi-

(1) Winterton C. Curtis, "Science and Human Affairs."

New York, Harcourt, Brace and Company, 1922, p. 232.

(2) The National Society for the Study of Education" 46th Year Book. Distributed by the University of Chicago press Chicago 37, Illinois, 1947. p. 295

dered as wasted. Actually we need to make good teaching so appealing that a greater number of our superior youth will find their best opportunities in science teaching. Let us pay them well and when selecting them let us pay enough attention to the following points:

1 - Serious selection, from the beginning with special consideration of their I. Q's, attitudes and character.

2 - Serious training and adequate academic specialization during the period of preparation. The old idea that those who know can teach is no more accepted. It is in this connection that Powers says: "The program of teacher education should be judged from the standpoint of its adequacy for the liberal education and from the standpoint of its adequacy for professional education."⁽¹⁾ Let us add what Noll says in this connection also; he says that, "Prospective science teachers should have some training in all the natural sciences commonly taught in secondary schools and that some training in related fields like mathematics is also highly desirable. It may also probably be said even without scientific studies to support the assertion, that the science teacher should have some ingenuity in putting together home made apparatus with the aid of local druggist, plumber, and hardware dealer. The beginning science teacher is often confronted with the necessity of getting along with entirely inadequate or non-existent laboratory facilities."⁽²⁾ This is perhaps more significant in the case of our schools which have not yet well equipped laboratories.

(1) S. Ralph Pwers. "National Society for the Study of Education" 31st Year Book. Part 1, 1932, Public School Publishing Company. Bloomington, Illinois, chap. XVIII. p. 323

(2) Victor H. Noll. "The Teaching of Science in elementary and Secondary schools" Longman, Green & Co. New York, London, Toronto, 1942 page 198.

This is true also as far as the number of science teachers is concerned. Therefore, when a teacher is so prepared as to teach effectively all the natural sciences in a secondary school, the benefit is greater. Nevertheless, this should not exempt us from preparing the needed number of science teachers.

3 - Serious follow-up after the training is over. The professional teacher must always come back to the teachers' college for discussing the various problems he encounters in the teaching process. On the other hand, the program of science teachers preparation must not be rigid. It should change with the outcome. Here is Noll again, who says that " We need also to study the effectiveness of the training given to prospective teachers. Their success in teaching should be carefully determined after they actually go to the work. By studies of the success of teachers in service in relation to the training they have had, we may learn much about what we are attempting to do for them, and about the weaknesses and the strong points in the program. The real test of a training program is how it works, how well it prepares teachers for what they have to do."⁽¹⁾

4 - Serious evaluation of the teacher's work and fair reward for his activity and achievement. Motivation, encouragement, and fairness are best ways to secure increasingly rich outcomes.

5 - Confidence in well prepared teachers and sufficient freedom to them, all together with a sense of responsibility, are imperative also. Let us conclude by quoting the following paragraph: " The teacher of today must be an educational scientist.

(1) op,cit p. 210

He should be capable of analyzing and evaluating new teaching methods, of carrying on class room experiments, and of continually seeking new educational material. This type of activity necessitates the understanding method, educational statistics, and a scientific vocabulary. Teacher growth is equally as important as pupil growth. The increased democratization of administration makes it necessary that teachers be more highly trained and competent because of increased breadth of knowledge of the many areas involved in the process of educating. They must also possess a greater insight into the proper development of the whole child than was possessed by the average teacher in the past."⁽¹⁾

C. Improvement and Reorganization of Curricula: - Although preparation of science teachers is the starting point, teaching outcomes will greatly suffer unless the curricula are made flexible and consequently the teacher feels some freedom to modify or change according to the learner's needs and teaching situations. Those who usually put and organize the curricula should always bear in mind a progressive and clear philosophy of education as we have seen in the previous chapter. The alert teacher should lead the students to participate in the making of daily program. They should feel that they solve their problems and discover what they like to do. This is impossible of course, with a rigidly prescribed and inflexible program. This is also impossible with the actual system of examinations prevailing in

(1) Arthur G. Hoff, "Secondary School Science Teaching" Philadelphia The Blakiston Company, Toronto, 1947, p. 250

Syria. Unless a radical change is made in both the curricula and the system of examinations the improvement of science teaching will remain beyond reach. We have discussed amply the problem of examination in the previous chapter and there is no place here for more comments. Let us, therefore, close by quoting Raths who says that, "Any 'interpreting' situation whether 'teaching' or 'testing' should give students opportunities to reveal whether or not they possess (the desired attitudes) skills."⁽¹⁾ In other words, examinations should be both valid and reliable. It is perhaps worthwhile to mention here the steps which should be considered in constructing objective tests, whether they are teacher-made or standardized. Here are the steps summarized from Noll's -

- 1 - Deciding on the objectives, principles, and attainment to be tested.
- 2 - Deciding on the types of items; i.e, whether true-false, multiple choice, etc; or the combination of types to be used.
- 3 - Constructing items to cover content to be tested.
- 4 - Arranging the items in the test
- 5 - Making the scoring key.
- 6 - Determining time limits of test.
- 7 - Administering the test
- 8 - Scoring the test.
- 9 - Tabulating the results
- 10- Interpreting the results. (2)

(1) Raths Louis " Appraising Certain Aspects of Students achievements' 37th Year Book of the National Society for the Study of Education. Part I, Guidance in Educational institutions Chap. III.

(2) Victor H. Noll "The Teaching of Science in Elementary and Secondary Schools" Longmans, Green & Co. , New York, London and Toronto 1942 p. 161

D. The Need For More Decentralization.- The public education in Syria is highly centralized. We are not going to discuss here the advantages and disadvantages of this system. What we would like to say is that a narrow centralization cannot help in the progress of our schools. It is not, for example, practical at all for a principal of a secondary school to have to get official permission from the central authority in Damascus, every time he wants to take the school or certain classes of it on a scientific trip, and yet this is the case in this part of the world. This centralization includes every thing in education. It includes both the internal and the external of education. I think that this is an exaggeration on the part of the Ministry of Education. To prevent the presupposed misuse, it should prepare teachers, inspectors, and employes in such a way as to have confidence in them and in the use of their authorities. Let them be wisely free and at the same time wisely responsible. Thus opportunities for innovation and initiation can be found, and better results may be expected. Even our method of teaching will remain rigid unless more decentralization is gained.

E. New Methods of Science Teaching :- We have seen that not one method alone is the best method in science teaching. The good teacher will adapt the method to circumstances. Nevertheless, it has been shown that the project method and the unit-problem method (both including laboratory research) are usually better than the others. They are better because they help more the student to satisfy his needs and grow. Through these methods the learner is

stimulated to learn because he himself wants to know, not because the teacher has told him that these subjects are good and may be useful in the future. Thus through these methods the learner works out of interest; consequently the outcome is greater and discipline is easier. On the other hand, he gets a healthy attitude toward science which is the most important objective of science teaching. Let us mention by the way that we need in this part of the world at least a series of attitude tests to show us the kind and strength of attitudes our schools create in the student. These tests are also useful to show the extent to which we succeed in creating desirable attitudes in our students. Dr. F. D. Curtis of the University of Michigan, for instance, has made a careful investigation of the views of a number of able teachers as to the characteristic of scientific attitudes, and has drawn a summary as follows: - (with interpolation) A person who has the scientific attitude:-

" (1) - Has a conviction of universal basic cause and effect relations; he believes in the orderliness of the universe, that natural law always functions, and that there is an understandable cause for every effect.

(2) - Has an interest and curiosity in the causes for happenings which impel him to make careful and accurate observations carefully collect and evaluate data and persistently search for the real causes.

(3) - Has the habit of caution in taking stands, expressing opinions and establishing prejudices. He waits for all the facts

and weighs the evidence before arriving at conclusions.

(4) - Weighs evidence not quantitatively but qualitatively as well; he is not convinced because of the number of times a statement is repeated but his evaluation is the result of his estimate of the pertinence, the soundness and adequacy of the evidence.

(5) - Has respect for another's view-point, is open minded tolerant of opposing views and is perfectly willing to go over to the opposite view if the evidence is sufficient to justify it."(1)

To measure these attitudes tests are necessary.

F. Laboratory Work In Science - "Learning by doing" is actually a sound principle in educational psychology. That is why Hoff has said that " the primary objective in determining a technique of instruction is to provide for a maximum pupil activity. This pupil activity must be efficiently directed in order that the objectives of education may be achieved to the greatest possible degree." (2). Perhaps the laboratory work is the best way to attain these objectives in science teaching. "Children can be in the process of growth toward science objectives if they respond to the challenges and problems with which the environments are filled. Children may seek explanations of many of the events they encounter. In turn, the explanations they understand and accept as children have much to do with the kind of individuals they will be when they become adults."(3)

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- (1) Dr. P. D. Curtis, "Journal of Chemical Education" 3:920 -927, 1926.
- (2) Arthur G., Hoff "Secondary School Science Teaching " Philadelphia. The Blakiston Company. Toronto 1947, p. 181
- (3) The National Society for the Study of Education" the 46th Yr. B. Part I. Science Education In American schools, Edited by Nelson B. Henry, The University of Chicago Press, Chicago 37, Illinois 1947, p. 60

Thus the effect of methods is not restricted to the present but it expands also to the future. What should we do, therefore, in order to give the student the best help possible which enhances his scientific growth in a wholesome way? Let us repeat here that we should provide him with a rich, stimulating and challenging environment. This will lead him to think and contemplate; but this is not the whole thing. The intelligent teacher is not satisfied by only stimulating the mind of his pupil but also by guiding him through the use of "trade materials" to experiment and test his thinking and hypotheses. It was in that sense that Twiss has said: "In an ideally arranged course of science study he (the student) would go to the laboratory just as the scientist does - to find out at first hand by special appropriate observations and experiments certain essential facts of observation which he needs in the mathematical investigation of a scientific problem, and which he cannot so conveniently or effectually find out elsewhere."⁽¹⁾ The student, therefore, should go to the laboratory with a problem to be solved or with a hypothesis to be tested. Let us add here that the student should make acquaintance with laboratories as early as possible; he should be trained to know how and where to locate instruments and materials; he should be warned about dangers and accidents which might happen during laboratory work. Even in the very classical teaching of science, Hoff recommends all these cautions to be taken. "It is not enough" says he,⁽²⁾ to give the

(1) George Ransom Twiss, "A Textbook in the Principles of Science Teaching." The MacMillan Company, New York, 1938, p. 126

(2) These are minimum requirements that our actual Syrian Science Teachers must be asked to do under the prevailing circumstances.

pupils a manual and let them go to the work in a laboratory without any further direction and discussion. Every laboratory period should begin with a discussion of the experiment to be performed. Caution and recommendations as to procedure should be clearly and thoroughly given. These helps, which can be suggested by the teacher can save pupils, specially the slower ones, a great deal of time and energy, thereby determining whether or not their activities in the laboratory will be successful. "(1) When the experiment is being performed, the pupils should be encouraged to make recordings about their observations of change in heat, in color, in reactions and about steps and results of experiments. This includes also the making of simple analytic drawings rather than representative ones. The aim is to show the structure and function of apparatus and things studied.

The intelligent science teacher should always bear in mind that "in every course of science offered at any level , opportunities should be provided for the pupils to perform experiments. The number of laboratory exercises performed by the pupil will vary with the course and should vary also with the individuals.⁽²⁾ Thus individual differences should be taken into full account in laboratory work also. Every single student has to receive the appropriate amount of care necessary for his continuous growth.

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- (1) Arthur G. Hoff, "Secondary School Science Teaching" Philadelphia. The Blakiston Company, Toronto, 1947, pp. 173-174.
 - (2) The National Society for the Study of Education" the 46th Year Book. Distributed by the University of Chicago press, Chicago 37. Illinois 1947 p. 53

"The best way to be sure that pupils will learn to do anything is to give them the opportunity to practice doing this very thing."⁽¹⁾ This is more significant in the case of less able pupils who usually receive less care and attention, unfortunately. The school and laboratory should fulfil the two functions which President Eliot, in 1906 attributed to them. He said "There are, then, two quite distinct functions which schools and laboratory perform. They tend to rouse the observational powers of the average and they give a chance to men of remarkable capacities to develop these capacities."⁽²⁾

We have been dwelling long enough on the laboratory work, because we believe it to be the corner stone of science teaching and because it is the most important factor lacking in our schools. Even while leaving this topic we feel that many other things should have been said. The limitation of space does not permit more details. Nevertheless, before closing let us ask ourselves where the science courses should be taught? Should they be taught in a usual classroom or in a laboratory? To answer this we quote the following paragraph from the 46th Year Book. "Ideally every science class should be conducted in a room which is a combination of class room and laboratory; in such a room discussion, demonstration, pupils examination, and other activities can be introduced at the most suitable time. There are likely to be occasions when it is desirable to have the laboratory work continue during several days or to introduce it at some point during a class discussion when it is needed for answering a question or clarifying a concept. By so

(1) Journal of Chemical Education, Ralph, E. Hoston, Vol 6. N:6 June 1929, P. 1131

(2) The National Society for the Study of Education. The 31st Year Book, P. 319.

doing a better use of time is assured than is possible under conditions in which laboratory work and classroom activities must be carried on in different rooms and on different days. It is practicable to design complete and satisfactory combinations of classroom and laboratory which occupy less place than would be occupied by both separately."(1)

Finally to stress the positive role of laboratories in teaching science and to stimulate our teachers in this part of the world I desired to summarize what the 46th Year Book considers as the role of laboratory in science teaching - Here it is. " Problem solving activities are an integral part of science teaching and learning and the science laboratory is a natural place for pupils to engage in these activities. To avoid the "cook-book recipe" type of laboratory work, the following approaches are suggested :-

- 1 - Use laboratory work to give the pupils practice in raising and defining worth while problems.
- 2 - The teacher should guide the pupils in stating problems early.
- 3 - Each problem should present a single clearly defined question.
- 4 - Through the laboratory period the teacher should make every effort to see that the pupils keep the object of the experiment continually in mind.
- 5 - Conduct laboratory work in such a way that pupils will learn the meaning and the use of control in experimentation.

(1) The National Society for the Study of Education. The 46th Year Book. Distributed by the University of Chicago Press. Chicago 37, Illinois 1947, P. 57.

- 6 - Use laboratory work to test hypotheses and interpret data.
- 7 - Maintain a proper balance between student exploration and teacher guidance." (1)

G. Scientific Trips: Field trips and scientific visits should find a respectable place in our curriculum. Nothing like trips and journeys (when possible) can help the student to understand the natural phenomena and social aspects. Through these trips the student is put in direct contact with the fact he is studying; he sees it, hears and touches it, deals with it and finally forms his concept about it. These trips, therefore, foster scientific inquiry and widen the pupil's horizon. Sumner says in this connection that "Factory and works visits from the point of view of fostering scientific inquiry, for providing a basis for possible 'project', for supplementary work in the classroom and laboratory, and for the development of local interest, should form a part of every science course." (2) The alert teacher should prepare as many field trips as possible in order to make his students know scientifically their environment with which they are dealing. When studying the unit (water) for instance, it is quite necessary for him to have his students see how water in the locality is provided, how it is purified and distributed to the houses. He has to stimulate the interest of his students to know how ice is made, the ammonia cooling system, how ice cream is made, cold storage,

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- (1) The National Society for the Study of Education. 46th Year Book. p. 235-236
 - (2) W. L. Sumner, "The Teaching of Science," Oxford: Basil Blackwell, 1947, p. 158.

pasteurization of some food products, the use of solid carbon dioxide, how does a refrigerator work, etc... All these subunits and many others may be more easily and deeply understood through such trips. A trip to a hospital is necessary also; it offers an opportunity to see besides other things X-ray, blood testing, examination of microorganisms, and the technical laboratories. This makes the student believe in science and in the future of mankind. Trips to museums, to glass, cement, alcohol, oil and soap factories are also necessary. But let us remember that as long as permission from the central authority is needed every time the school likes to go on a trip from one town to another, the possibility of profiting from trips is limited. That was why we also asked for more decentralization in the previous pages.

H. Science Clubs: The idea of having any club in the school is quite good and entirely in line with our philosophy of education which states that our real growth occurs only within a social environment. Hoff, when dealing with clubs in school says: "From the social point of view, the club fosters school spirit and loyalty to the school and the group, develops cooperation and permits the spirit of service. Nearly, every club in a school has one of its major objectives the improvement of the school community. This activity tends to promote a conscious responsibility in attempting to influence other pupils in cooperating for the betterment of the school."⁽¹⁾ This is true for clubs in general.

(1) Arthur G. Hoff, "Secondary School Science Teaching" Philadelphia. The Blakiston Company, Toronto 1947, p. 213.

Besides these advantages the science club helps to:

- 1 - Promote interest in science among pupils and citizens.
- 2 - Make the applications of science to daily life well appreciated and understood.
- 3 - Carry out some complicated experiments emerging from the members' interest.
- 4 - Provide educational and vocational guidance for the members.
- 5 - Provide scientific discussions of industrial, agricultural, or other scientific topics, and it helps to provide scientific films, scientific lectures and scientific trips.

Thus if the club is well directed and supervised by the school it may be a major factor for the students' growth. In a science club, closer personal contact between students and the science teacher is made possible, because of the informal and free atmosphere. "This informal and free attitude", says Hoff, "develops more personal feeling and loyalty between pupil and teacher which is desirable."⁽¹⁾ Thus in an ideal club the cooperation between the teacher and the pupil is very obvious. The former stimulates, guides and directs the latter's activities and work. As the question of science clubs is so important and relatively new in this part of the world, we better go into some details and mention some necessary conditions for the foundation of clubs in school. There seems to be rather general agreement regarding the following points in the process of club formation:

(1) Op. Cit p. 212

- a - Some faculty members must be responsible for the Club.
- b - Guidance and supervision have proven to be necessary. Unsupervised initiations may have an element of danger in them.
- c - The officers must be students; the club is for the students.
- d - There must be a definite time and place for the meeting.
- e - A program committee must be selected to provide worthwhile programs. Some outsiders may be invited to speak to the members about industrial, agricultural, geological, hygienic or other professional topics or works of life. Only rarely should they be teachers, unless they are from other schools.
- f - The program must be varied so that each meeting offers something of interest to all members. Illustrated talks are usually of greatest interest and short ones are better than long ones unless the latter are exceptionally good.
- g - The program of a chemistry club, for instance, should not teach too much. The purpose is to inspire and develop interest more than to teach chemistry.
- h - Surprise or mystery demonstrations, working models of industrial plants, moving pictures and similar unusual items often enhance the value of the club program.
- i - The committee must remember that full attendance must be won by good programs. It cannot be enforced by fines and rules. (1)

(1) These items are adopted from, and reorganized after, F. O. Frank, "The Teaching of High School Chemistry", Published by the I.O. Frank and Sons. Oshkosh, Wis 1932, pp. 179-180.

So much for science clubs; ⁽¹⁾ let us discuss now another aspect of extracurricular activities, namely:

I. The Library in Science Teaching: Science books and periodicals are entirely lacking in our Syrian schools. The reason for this lack is mainly two fold: first, because we have no such books in Arabic, suitable for different levels of growth; and secondly, because we have not yet paid enough attention to translation. Only very recently a few books on science in Egypt and Lebanon have been translated from English and French. It is the writer's hope that this movement of translation will gain in momentum and ultimately will give rise to another movement of writing appropriate books and periodicals designed for various levels of growth in science. It is the duty of the government to encourage, enhance and perhaps to adopt this constructive movement. Actually, children in this part of the world do not enjoy what their age mates do in Europe or America. Our children have no opportunities for constructive play, for outside reading, for directed leisure time and for activities. That is why unless the government takes the lead in this field, especially under the prevailing cultural and economic circumstances, children's growth will suffer a lot. The need for a library in the school is, therefore, so great that the school will remain inadequate until it provides a good one. We should pay enough attention and care to the science library particularly. The science library should contain interesting books in

(1) For more details the reader is referred to Heiss, Oboway and Hoffman, "Modern Science Teaching" The Macmillan Company, New York 1950. pp. 233-244.

order to attract pupils to read more. Besides textbooks, science stories and illustrated magazines, the library should include materials related to drawing, model engineering, photography etc... "The real backbone of the science library, however, should be books of reference both for teacher and scholar, in addition to a number of science reading books apart from textbooks. The inquiring child should be directed to suitable sources of information so that after a time he will know how to use the library".⁽¹⁾ Let us stress here that providing a library is not enough; what is important is to teach students how to use it. Students must know how the library is arranged, how to find a given reference and how to locate information. Not only this, but Sumner adds also "That it is advisable to give some instruction to prepare for later systematic reading of books from lending libraries, and also the use of reference departments for obtaining detailed information on any subject."⁽²⁾ This is all in line with our philosophy of education which implies that education is life and life is growth without limits. The school, therefore, should develop interest in science in the majority of children who usually have left the school. This is because science makes their lives easier and more meaningful. The intelligent teacher strives to make his pupils like to read and know how to choose books to be read. He should help them and guide their efforts through studying. How to study is an art which should be acquired by every individual student. The writer recommends

(1) W. L. Sumner, "The Teaching of science", Oxford, Basil Blackwell, 1947, P. 186.

(2) *ibid.* p. 186.

also the introduction of a special course called "How to Study" in the case of our curricula. Unless our efforts are guided, and our aim is clear the outcome will be poor and the time wasted.

J. The Films in Science Education: This is another means for providing science teaching. Through moving pictures, learning is made real because it is a reproduction of the actual machine, plant, animal or process. That is why Hoff says that "The instructional moving picture possesses nearly all the advantages of a field trip." Furthermore, the films provoke many insistent questions in the mind of pupils. The intelligent teacher will not destroy the educational value of these questions by answering them immediately in an authoritative manner. The students themselves should think out observe, and keep in mind these questions with sufficiently long consideration until they reach the answers. Thus the student should not be passive, only seeing the films. It was in this connection that Wood and Freeman said: "The films are intended to leave the pupils at the end with so many concrete and detailed impressions that the end of the picture will be in effect, the beginning of increasingly satisfying efforts on the part of each pupil to interpret his own experience and answer his own questions." This advantage, however, is proportional to the ability of those who select the films and present them at the appropriate time and place.

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- (1) Arthur G. Hoff, "Secondary School Science Teaching," Philadelphia. The Blackiston Company, Toronto 1947. p. 227
(2) Dr. Wood and Dr. Freeman in the Journal of Chemical Education, January 1929, p. 156.

The advantages of films in science education have been studied by many investigators. One of the most comprehensive studies on the effectiveness of sound moving pictures in the teaching of science was made by Ronlon⁽¹⁾ who gave the following results:

- 1 - The increase in pupil's achievement ascribable to the use of the film may be expected to exceed 20%.
- 2 - For facts and relationships specifically dealt with in the film - caused increase in pupil's achievement may be expected to exceed 35%. The investigators added that:

neither of the above two gains may be expected to be made at the expense of more important but less definable educational values such as good habits of thinking!⁽²⁾

There are other teaching aids which can promote the teaching of science such as pictures projectors, magic lanterns, radios and even television which we are not going to discuss here because of the limitation of space.⁽³⁾

These are only suggestions presented for the consideration of the Ministry of Education and Science Teachers in Syria. It is the writer's hope that they will prove to have some benefit and good effect in the promotion of science teaching and in the acquisition of the scientific spirit we need so badly. Let us repeat here that these suggestions and recommendations will have no great value unless the other aspects of our social and national life are improved at the same time.

(1) Philip W. Ronlon, "Sound Motion Pictures In Science Teaching," Cambridge, Harvard University Press 1933, P. [2]

(2) *ibid.* p. (2)

(3) For further details the reader is referred to the works of Paker, Bossing, and Heiss, abowmy, Hoffman, etc.

A P P E N D I X

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Power General Chemistry Test

By

S.R. Power, Ph.D.

Power's General Chemistry Test

By

S.R. Power, Ph.D.

Examination form A

Do not open this paper or turn it over, until you are told to do so. Fill these blanks giving your name, Age, Birthday Write plainly.

Name

Age last birthday Year

Class

How many months have you studied chemistry

School or college

City

Date of examination

Directions.

This is a test of ability to do tasks in chemistry. The direction for each division and the tasks are given on the following pages. When you turn the page you will find directions for part I. Read the directions and begin immediately with the test. When you have finished as much of part I as you are able to do go immediately to part II, in a similar manner. Read the directions for part II and do as much of it as you can. Do not stop until you have completed as much as you are able to do of both part I and part II. You will be allowed 35 minutes to complete both parts of the test.

Part I

Directions. Part I is a test of range of information about chemistry. In each of the statements there are five choices for the best word or word group. Only one of them will make the statement correct. In each sentence draw a line under one of these words or word groups which makes the truest sentence. Notice the sample sentence.

Sample. Water is a compound of hydrogen and

Zinc, Nitrogen, Oxygen, helium, chlorine.

The word oxygen is underlined because it makes the truest sentence. Following are 30 sentences like this one. Do them in order and complete as many as you can.

Begin here.

- 1- Substances which hasten a chemical action without themselves undergoing chemical change are called:
Catalysts, electrolytes, ionogens, allotrops, colloids.
- 2- Oxygen was first prepared from chemicals by:
Boyle, Priestley, Arrhenius, Hall, Edison.
- 3- An essential constituent of all baking powders is:
Alum, cream of tartar, phosphates, sodium bicarbonate, ammonium sulfate.
- 4- Hydrogen fluoride is used for :
Bleaching, etching glass, preserving, disinfecting, deodorizing.
- 5- The acid which is contained in vinegar is:
Tartaric, lactic, acetic, oxalic, citric.
- 6- The sulfur used in commerce:
is mined, is made from chemicals, is extracted from plants, is a product of decay, comes out from the ocean.

- 7- Acids are characterized by the fact that when in solution they form ions of:
Oxygen, hydrogen, metal, non metal, hydroxide.
- 8- Chlorides may be most completely precipitated from solution by addition of:
Mercury nitrate, silver nitrate, lead nitrate, copper nitrate, magnesium nitrate.
- 9- Alcoholic fermentation results from the action on glucose of : Bacteria, organic acid, parasites, yeast, light.
- 10- Cotton fiber is nearly pure:
Levulose, dextrose, lactose, cellulose, invertose.
- 11- The effect of pressure upon the volume of a gas at constant temperature was first measured by:
Rault, Henry, Dulong and Petit, Boyle, Charles.
- 12- Ordinary soap is a compound of a fatty acid radical with:
Potassium, sodium, calcium, lithium, magnesium.
- 13- Ammonia is obtained as a by-product from the manufacture of: Fertilizer, liquid air, coal gas, soda, soap.
- 14- The two elements contained in practically all fuels are carbon and :
Oxygen, nitrogen, helium, sulfur, hydrogen.
- 15- Foods which contain nitrogen as a part of their chemical composition are:
Fats, carbohydrates, proteins, hydrocarbons, vitamins.
- 16- Wool is often bleached with:
Chloride of lime, sulfur dioxide, bromine, carbon tetrachloride, citric acid.
- 17- Commercial glucose is made from:
Starch, cane sugar, beet sugar, cellulose, maltose.

18- Sulfuric acid is used very extensively as a :

Solvent, cleaning agent, bleaching agent, preservative, dehydrating agent.

19- Platinum is used as a catalytic agent in the manufacture of sulfuric acid by the:

Contact process, chamber process, electrolytic process, Brin process, chance process.

20- The oxygen of commerce is made chiefly from:

water, potassium chlorate, barium peroxide, liquid air, sodium peroxide.

22- The most important of the lead ores is:

Lead oxide, lead sulfate, lead sulfide, lead chloride, lead carbonate.

23- Alum is added to water at city filtration plants:

To kill bacteria, to soften the water, to precipitate calcium, to coagulate the colloidal material, to make it pure.

24- Natural water is not considered safe for drinking if chemical tests show the presence of considerable amounts of: Metallic salts, sulfates, chloride, alkalis, minerals,

25- Increasing the valence of positive element and decreasing the valence of negative element is called:

Activation, ionization, valence, oxidation, catalysis.

26- One compound that will not dissolve in strong hydrochloric acid is:

Calcium carbonate, calcium oxalate, zinc hydroxide, ferric sulfate, barium sulfate.

18- Sulfuric acid is used very extensively as a :

Solvent, cleaning agent, bleaching agent, preservative, dehydrating agent.

19- Platinum is used as a catalytic agent in the manufacture of sulfuric acid by the:

Contact process, chamber process, electrolytic process, Brin process, chance process.

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25- Increasing the valence of positive element and decreasing the valence of negative element is called:

Activation, ionization, valence, oxidation, catalysis.

26- One compound that will not dissolve in strong hydrochloric acid is:

Calcium carbonate, calcium oxalate, zinc hydroxide, ferric sulfate, barium sulfate.

27- The protein in wheat is called:

Glialin, gluten, albumen, casein, piptane.

28- Burning of wood is an:

Electrolysis, reduction, chemical change, Physical change, catalysis.

29- The number of atoms of hydrogen which an atom of any element will displace or combine with is called its:

Chemical activity, atomic volume, valence, equivalent weight, atomic number.

30- The addition of sodium acetate to acetic acid solution:

Activates the acid, decreases the hydrogen ion concentration, increases the hydrogen ion concentration, neutralizes the acid, has no effect.

.....

Part II

Directions: Part II is a test of ability to do tasks in chemistry. Directions are given as needed in the book of the test. You are asked to make calculations. All atomic weights needed are given here. Do not waste time.

H 1	Cl 35.5	Na 23	Cu 64
S 32	N 14	C 12	
O 16	Zn 65	Ca 40	

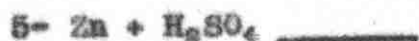
Begin here.

The valence of the following elements and radicals is as indicated: Li^+ Mg^{++} Al^{+++} Cl^- Br^- $(\text{SO}_4)^{-}$. Insert subscripts where they are needed to make the following formulas correct. Do nothing to those already written correctly. Example: The subscript 2 makes K_2SO_4 correct, while KSO_4 is incorrect.

1- $\text{Li} (\text{SO}_4)$

- 2- MgB_2
- 3- $Al(SO_4)$
- 4- $AlCl$

Fill in the right-hand side and balance the following equations:



8- The formula H_2SO_4 indicates that the elements are in combination in the ratio of _____ gram (s) of hydrogen to _____ gram (s) of sulfur to _____ gram (s) of oxygen.

Write the molecular formulas for the following:

- 9- Sodium sulfate.
- 10- Hydrogen sulfide.
- 11- Silver chloride.
- 12- Potassium carbonate.
- 13- The equation $Zn + 2HCl$ _____ $ZnCl_2 + H_2$ indicates that _____ gram (s) of zinc decompose (s) _____ gram (s) of hydrochloric acid and form (s) _____ gram (s) of zinc chloride and _____ gram (s) of hydrogen.

Write the names of the following compounds:

- 14- Na_2SiO_3
- 15- K_2SO_3
- 16- $Ca(HCO_3)_2$
- 17- $NaNO_2$
- 18- The weight of a liter of a certain gas is 0.18 gram. The molecular weight of the gas is _____
- 19- The formula for copper sulfate $CuSO_4 \cdot 5H_2O$, indicates that 250 grams of the crystals contain _____ grams of water of crystallization.

- 20- A certain substance contains 75% carbon and 25% hydrogen.
Its simplest formula is:

Write the chemical name for the substance or substances of which the following are chiefly or entirely composed:

21- Lime stone

22- Sand

23- Blue vitriol

24- Laughing-gas

25- A quantity of gas measures just one liter at 25°C. After the temperature is changed to -11°C (11° below 0°C) the volume becomes _____ liters (pressure is constant).

Write the equation using correct molecular formulas for each of the following chemical changes:

26- The action of sodium on water:

27- The laboratory preparation of ammonia gas from ammonium chloride and slaked lime:

28- The preparation of oxygen from potassium chlorate:

29- The decomposition of sodium bicarbonate by heat:

Fill in the right hand side and balance the following equations:



Write the structural formula for each of the following substances:

33- Chloric acid

34- Potassium chromate

35- Acetic acid

36- Arsenious sulfite

37- One oxide of nitrogen contains 63.64% nitrogen and 36.37% oxygen; another contains 25.92% nitrogen and 74.08% oxygen. The ratio of the number of atoms of oxygen in the molecule of the second is _____ to _____.

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-

مقياس في الكيمياء العامه

لا تفتح هذه الورقة ولا تقلبها الا بعد الاشارة من الاستاذ . اكتب بوضوح :

الاسم : عدد الاشهر التي درست فيها الكيمياء :

تاريخ الولادة : الشهر :

اسم الصف : اسم المدرسة :

مكان الولادة :

السنة :

الارشادات

هذا مقياس لمقدرة الطلاب في الكيمياء ، يتألف من تسمين . سترى ارشادات القسم الاول بعد عدة اسطر . اقرأها اولا وابدأ رأساً بالاجابة على الاسئلة . اذا انتهيت القسم الاول او انتهيت ما تعرفه منه أذهب مباشرة الى القسم الثاني من الاسئلة . وينفس الطريقتين اقرأ ارشادات القسم الثاني واجب عن الاسئلة التي تعرفها . لا تقف قبل ان تجيب على ما تعرفه من القسمين الاول والثاني . الوقت المحدد لانهاء العمل ٣٥ دقيقة .

ارشادات القسم الاول

ان القسم الاول هو اختبار لمدى معرفة الطالب للكيمياء . ترى لكل سؤال خمسة اجوبة احدها هو الجواب الصحيح . ضع خطأ تحت اصح جواب تراه .

مثال : الماء مركب من هيدروجين و

توتيا . آزوت . اوكسجين . هيليوم . كلور

وضعنا خطأ تحت اوكسجين لانه اصح الاجوبة . فيما يلي تسمى (٣) سوئالا كنهذا اجب بالترتيب على اكبر عدد تستطيع الاجابة عليه .

ابدأ هنا

- ١- ان الجسم الذي يسرع التفاعل الكيميائي دون ان يعاني هو اى تغير وسيط . محلل . مرجع . مؤكسد . صمغي
- ٢- ان الذى استحصل الاوكسجين اولا من المواد الكيميائية هو بويل . بريستلي . اريستينوس . هول . اديسون .
- ٣- المسحوق المساعد على انتفاخ العجين (تخميره) قوامه الشب . زبدة الطرطر . فوسفات . ثاني فحمات الصوديوم . كبريتات النشادر .
- ٤- يستعمل حمض الفلور في قصر الاقمشة . حفر الزجاج . الحفظ . التطهير . ازالة الروائح .
- ٥- الحمض الذى يستخرج من تخمر ماء العنب حمض الطرطر . حمض اللبن . حمض الخل . حمض الحماض . حمض البيرون

- ٦- الكبريت المستعمل في التجاره .
يستخرج من المناجم . مصنع من مواد كيميائية . يستحصل من النباتات
هو نتيجة تفسخ . مستخرج من البحر .
- ٧- تتميز الحموض وهى محلوله بخاصة تكونها شوارد
الاوكسجين . الهيدروجين . المعدن . شبه المعدن . الاساس
- ٨- ترسب كلوروك الاجسام من محلولاتها باضافة
آزوتات الزئبق . آزوتات الفضة . آزوتات الرصاص . آزوتات النحاس
آزوتات المغنيزيم
- ٩- ينتج التخمر الكحولي من تأثير احد الاشياء الاتية في الغلوكوز
بكتيريا . حمض عضوى . طفيليات . خميره . النور
- ١٠- تكاد تكون الياف القطن مجرد
ليفيلوز . ديستروز . لاكتوز . سللوز . انفرتوز
- ١١- اول من قاس تأثير الضغط على حجم الغازات في درجة حرارة ثابتة هو
راؤولت . هنرى . دى لونج وييتي . بويل . شارل .
- ١٢- يتركب الصابون العادى من جذر حمض المواد الدسمه مع
بوتاسيوم . صوديوم . كالسيوم . لسيوم . مغنيزيم
- ١٣- يستخرج غاز النشادر اثناء صناعة
الاسمه . الهواء السائل . غاز الفحم الحجرى . الصودا الصابون .
- ١٤- المنصران اللذان يحويهما كل نوع من انواع المحروقات هما الفحم و
الاوكسجين . الآزوت . الميليوم . الكبريت . الهيدروجين .
- ١٥- ان المواد الغذائية التى تحوى الآزوت تقسم من تركيبها الكيميائي هي
الشحوم . النشاء . البروتين . الفحم الهيدروجينية . الفيتامينات
كلور . ايج الفحم
- ١٦- يقصر الصوف غالبا γ
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- ١٧- يستحصل الغلوكوز التجارى من
النشاء . سكر القصب . سكر الشمندر . سللوز . مالتوز
- ١٨- يستعمل حمض الكبريت كثيرا جدا
كغذيب . للتنظيف . لقصر الاقمشة . للحفاظ . كعامل لامتصاص الماء .
- ١٩- يستعمل البلاينيوم كوسيط في صناعة حمض الكبريت في طريقة
التاسر . غرف الرصاص . التحليل الكهربائي . برين . شانس
- ٢٠- يستخرج الاوكسجين المستعمل في التجارة بالدرجة الاولى من
الماء . كلورات البوتاسيوم . اكاسيد الباريوم . الهواء السائل .
اوكسيد الصوديوم

٢١ - يقصر القطن غالباً بواسطة
كلور الكنسر . ثاني اوكسيد الكبريت . برومين . فحمات الكلور الثلاثيه .
حمض الليمون

٢٢ - اهم فلزات الرصاص
اوكسيد الرصاص . كبريت الرصاص . كلوريت الرصاص . فحمات الرصاص

٢٣ - يضاف الشب الى المياه في مراكز تصفيتها .
لقتل الجراثيم . لجعل الماء يسرا . لترسيب الكالسيوم . لتخثير المواد المعلقه
لازالة رافحتها .

٢٤ - لا تعد المياه الطبيعيه عالحة للشرب اذا اظهر فيها الفحمر الكيماي وجود
كمية وافرة من

املاح المعادن . الكبريتات . الكلورات . المواد القلوية . المعادن
٢٥ - ان زيادة القوى الاتحاديه في العناصر الموجبه وتنقيص القوى الاتحادية في
العناصر السالبة تسمى

٢٦ - المركب الذي لا يدرب في حمض كلور الماء الشديد
فحمات الكالسيوم . كبريتات الكالسيوم . ماءات التوتيا . كبريتات الحديد .
كبريتات الباريوم .

٢٧ - يدعى البروتين في القمح
غلابادين . غلوتين . البومين كازين . بيتون .

٢٨ - احتراق الخشب هو
تحليل كهربائي . ارجاع . تغير كيميائي . تغير فيزيائي . . وسيط

٢٩ - ان عند جواهر الهيدروجين التي يستطيع اى عنصر آخر ان يحل محلها او
ان يتحد معها تسمى
فعاليه كيميائيه . الحجم الجوهري . قوى اتحاديه . معادل كيميائي .

العدد الجوهري
٣٠ - ان اضافته خللات الصوديوم الى حمض الخل الممدد
يزيد فعالية الحمض . ينقص كمية شوارد الهيدروجين . يزيد كمية شوارد
الهيدروجين . يعدل الحمض . لا اثر له .

IV.

ارشادات القسم الثاني

تحتاج في هذا القسم الى بعض الحسابات . لذلك نرى امامك جميع الاوزان الجوهريه التي تحتاجها . فلا تضع الوقت .

H 1
Cu 64
Zn 65
O 16

Cl 35.5
S 32
Ca 40

Na 23
N 14
C 12

ابدأ هنا . ان القوى الاتحادية للعناصر والجدور التاليه هي كما تظهر هنا

Li⁺

Mg⁺⁺

Al⁺⁺⁺

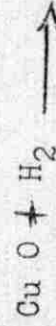
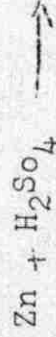
Cl⁻

Br⁻

(SO₄)⁼

ضع ما تراه مناسبا الى جانب التراكيب التاليه لتجعل الخطأ منها صحيحا . لا تعمل شيئا للتراكيب الصحيحه . مثلا : العدد (2) يجعل K₂SO₄ صحيحا بينما خطأ

1. Li(SO₄)
2. Mg Br
3. Al(SO₄)
4. Al Cl



اكمل المعادلات التاليه في الجهه اليمنى ووازنها

٥

٦

٧

٨ ان الصيغه H₂SO₄ تشير الى ان العناصر المركبه لهذا الحمض هي ()

من الهيدروجين و () من الكبريت و () من الاوكسجين

اكتب الصيغ الذريه للتراكيب التاليه :

١٠ كبريت الهيدروجين

١٢ فحمات البوتاس

٩ - كبريتات الصوديوم

١١ - كلور الفضة

١٣ - ان المعادله الاتيه Zn + 2H Cl → Zn Cl₂ + H₂ تشير الى انه ()

من التوتيا يحلل () غ من حمض كلور الماء ويؤلف () غ من كلور التوتيا

و () غ من الهيدروجين

اكتب اسماء الصيغ التاليه :

K₂ SO₃ ١٥

Na NO₃ ١٧

Na₂ Si O₃ ١٤

Ca (H co₃)₂ ١٦

١٨ ان وزن ليتر من غاز ما هو ١٨ بالمئه غرام ، ما هو الوزن الذرى لهذا الغاز ؟

١٩ ان الصيغه الذريه لكبريتات النحاس (Cu SO₄ . 5 H₂O) تشير الى ان

() غ من بلورات الماء .

٢٠ جسم ما يحوى بالمئه ٧٥ فحم و بالمئه ٢٥ هيدروجين . تركيبه الذرى هو ()

اكتب الاسم الكيميائي للمادة او المواد التي تتألف منها الاجسام الاتية كليا او في قسمها الاعظم .

٢٢ الرمل

٢١ حجر الكلس

٢٤ الغاز المضحك

٢٣ ازرق بروسيا

٢٥ كمية من الغاز حجمها ليتر في درجة الحرارة ٢٥١° فاذا هبطت درجة الحرارة الى (- ١١٠°) يصبح الحجم () في ضغط ثابت .

اكتب المعادلة مستعملا الصيغ الذرية الصحيحة للتفاعلات الكيميائية الاتية :

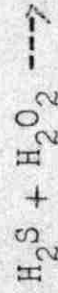
٢٦ تأثير الصوديوم في الماء

٢٧ استحصال غاز النشادر في المخبر من كلور الامونيوم وماءات الكلس

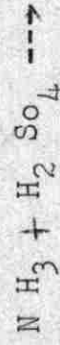
٢٨ استحصال الاوكسجين من كلورات البوتاسيوم

٢٩ تحليل ثاني فحمات الصوديوم بالحرارة

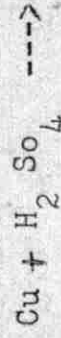
اكمل المعادلات التالية في الجهة اليمنى ووازيها



٣٠



٣١



٣٢

اكتب الصيغ الذرية لكل من التراكيب التالية

٣٣ كلورات البوتاسيوم

٣٤ كرومات البوتاسيوم

٣٥ حمض الخل

٣٦ كبريت الزرنيخ

٣٧ احد اكاسيد الآزوت يحوى (في المئة ٦٣، ٦٣) آزوت و (بالمئة ٣٦، ٣٧) اوكسجين

واوكسيد اخر يحوى (بالمئة ٣٥، ٦٤) آزوت و (بالمئة ٦٤، ٣٥) اوكسجين . فنسبة

عدد جواهر الاوكسجين في الذرة الاولى الى عدد اجواهر الاوكسجين في الذرة الثانية

هي كسبة العدد () الى العدد ()

Abstract

of

**A critical study of science teaching in Syrian
Public Secondary Schools - and Evaluation of Content
and Method in the Light of Modern Theory and Practice**

by

Zakiyyah Ibrahim-Pasha

It is the writer's belief that science teaching in Syria is still in its dawn and that we, as Syrians are in a period quite similar to that of Renaissance in the history of Europe. In this study the writer tries to trace back the cause of our retardness in the field of science particularly and to show the many of improvement. This cause is attributed to the dark ages of the Ottoman rule and to the French mandate later on. Hence, there is no wonder if we have not yet formed what we prefer to call "Science Traditions" although we used to have such traditions in our past golden ages. No wonder also if we see our methods of teaching science still inadequate or rather poor. This is not a mere guess or supposition, nor is it a mere logical conclusion based upon mental contemplation, it is rather based on a scientific inquiry in the matter of science teaching and science achievement. According to the experimental study the writer has made in Syria, the Syrian student was much more lower than his age mate in America, for instance, in his knowledge of science and of chemistry more particularly.

Let us remind the reader that as far as the intelligence is concerned, the modern psychology cannot pretend that there is an inherent difference between the intelligence of peoples. The observed difference is due to environmental factors. Thus we are justified therefore to say that our actual retardness is mainly due to our methods used in science teaching and to our philosophy of Education as well.

The aim of education should be the total growth of the student as Denney has said. This implies that science teaching should be in line with that general aim of education; it should help in the process of growth and development. It has been agreed among the educationists that the objectives of science teaching are the acquisition of :

1. Knowledge

- a. Knowledge of the facts, principles and applications of science.
- b. Knowledge which will produce a better understanding of nature and environment.
- c. Knowledge necessary to correct superstitions and erroneous belief.
- d. Knowledge which helps pupils for further work in science and for college and university entrance.
- e. Knowledge of principles of secondary education which are: Health, command of fundamental process, citizenship, worthy home membership, vocation, worthy use of leisure, development of ethical character.

2. Abilities

- a. Ability to go ahead - to self direction.
- b. Ability to use the scientific method of investigation.
- c. Ability to pick the false from the true, to cast away prejudices and lie ruled by reason, to make pupils able to let the intellect replace the emotion in influencing their decisions.
- d. Ability to present ideas clearly and convincingly.
- e. Ability to do house hold tasks such as removing stains from

clothing and to do successfully everyday work.

- f. Ability to apply critical thinking.
- g. Ability to apply skillfully the principles, generalizations and fundamental facts in new situations which arise in the pupil's daily life.

3. Skills

- a. Locating source materials.
- b. Using source materials.
- c. Solving mathematical problems necessary in obtaining pertinent data.
- d. Using talks and interviews as sources of information.
- e. Making observations suitable for solving a problem.

4. Habits

- a. Careful observation of significant facts and phenomena, using hands, eyes and ears before consulting books.
- b. Habit of recording results when the work is done.
- c. Habit of work and study including accuracy, thoroughness, persistence, good organization on planning and neatness.
- d. Habit of thinking that contributes to the scientific attitude.
- e. Habit of suspended judgment and criticism.
- f. Habit of punctuality.

5. Attitudes

- a. Accuracy in all operations including calculations, observations and reports.
- b. Holding conclusion as tentative until all necessary facts are secured.
- c. Intellectual honesty which involves the habit of submerging personal bias and prejudice and the habit of admit-

ting being in the wrong when proved to be so.

- d. Open mindedness which involves a willingness to consider new data, new facts, and unwillingness to accept a solution as final and ultimate.
- e. Efficiency or accuracy combined with speed.

5. Appreciation

- a. Appreciation of the value and importance of science as it affects pupil's daily life.
- b. Appreciation of cause and effect relationship.
- c. Appreciation of the value of science to society and to the individual.
- d. Appreciation of the place of man in science.

6. Interest

- a. Interest in the value, worth, and beauty of science.
- b. Interest in some phase of science as a recreational activity or a hobby.
- c. Interest in science as a field for a vocation.
- d. Interest in the social and industrial application of scientific principles and the work of research investigations.

It is clear now, after all what has been said that the science teacher should help his student to get a healthy and positive attitude toward science, otherwise the student would not like science and would remain anti-scientific in his outlook. That is why good and experimental methods which give rise to the scientific attitude are imperative. We cannot help being metaphysicist in our approach unless we get the scientific approach which was never more needed than it is nowadays. But

what is a good method? and is a good method alone enough? can we get good results if the curriculum is not well organized and if it is over loaded? further more, can we educate properly if we are bound to official examinations such as the "Certificat d'Etudes Primaires", "Brevet" and "Baccalaureat"?

Actually to get good results in teaching good method, well organized content and sound philosophy of education are needed. There is almost a general agreement that among the method used in science teaching the laboratory method has proved to be superior. This does not mean, of course, that the other methods are of no use. The lecture method, the demonstration method, and the unit problem method have their values also.

Unfortunately, we do not use extensively the laboratory method because of many things, among them are the following:

1. lack of well equiped laboratories.
2. lack of well trained and adequately prepared teachers of science.
3. over loaded curriculum and preparation for examination.

To have a good science teaching in Syria and to help students get a healthy and a scientific attitude the following items should be considered:

1. Science education has become imperative

Nowadays where the whole structure of our civilization is built upon science. Science makes for human understanding and human solidarity and better life. Through science man has got his freedom.

2. Preparation of science teachers

"The science teacher" says Curtis "is the major factor in

gaining better opportunities for true leadership ..."

Thus the preparation of science teachers is of prime importance. They should be selected seriously with a special consideration of their I.Q.'s, attitude and character. They should ^{be}adequately trained both academically and professionally. Not only this but a serious follow-up should proceed after the training is over. They should be encouraged and rewarded during the work. Finally they should enjoy the liberty of teaching as they like and as they see suitable to their students; no examinations should limit their creativeness and their philosophy of education.

3. Improvement and reorganization of curricula:

The alert teacher should lead the students to participate in the making of daily program. They should feel that they solve their problems and discover what they like to do. This is impossible, of course, with a rigidly prescribed and an unflexible program. That is why the Syrian curriculum should be reorganized and more flexible.

4. The need for more decentralization:

The public education in Syria is highly centralized. This centralization includes both the interna and the externa of education. It is too difficult to improve teaching of science with this strong restriction.

5. New methods of science teaching:

We have said that the laboratory method is superior; this is quite in line with Dewey's "Learning by doing". Actually science cannot be taught fruitfully without experimentation.

6. Scientific trips and scientific films:

To all this let us call the reader's attention to the importance of field trips and scientific journeys in science teaching. Thus the learner is in close contact with the facts and natural phenomena. The instructional moving picture possesses nearly all the advantages of a field trips.

7. Science clubs:

The club promotes interest in science and provide educational and vocational guidance for the members. If the club is well directed and supervised it may be a major factor for the student's growth.

8. The library in science teaching:

This is a very important item which is lacking in our Syrian schools, and unless we provide our schools with good libraries and help the students to use them our science teaching will suffer a lot.

As a conclusion we can say that if we like to have a genuine improvement in the teaching of science all these suggestions should be taken into full consideration. Let us provide for them and the progress will be our reward.
