THE SIGNIFICANCE OF SCIENCE IN THE HIGH SCHOOLS OF EAST PAKISTAN

A THESIS

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Science in the High School

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ABSTRACT

It is very often said that the present age is the "Age of Science". In its effect on material benefits and on mental outlook, science has gained recognition as a factor in the advancement of modern civilization. But the existing science program for the high school pupils of East Pakistan does not seem to reflect this changed status of science. The high school occupies an important place in the educational ladder of East Pakistan. Before or after the Matriculation Examination, pupils proceed to a number of life situations either by joining different professions or going on to higher education.

The present investigation has shown what role science has in the high schools of East Pakistan in the preparation of the good citizen, and what science he should know at this level to make satisfactory adjustments to various situations. The meaning of science for the present study has been limited to that aspect of scientific knowledge which is deemed useful for everyday living plus an understanding of the "scientific method" of dealing with problems.

From a study of a number of science textbooks and available literature, the importance of science in everyday life has been shown. Its importance as a high school subject has been indicated by the judgements of sixty Pakistani students of the American University of Beirut. This study

depended heavily on the cooperation of these students, who responded to questionnaires. Their experiences related to high school science courses, methods of instruction, science teachers, and the availability of laboratory facilities have been taken into account. A structured oral test was given to these university students to test their everyday science understandings.

It has been found that in the collective judgements of the sixty student judges, science occupies the third place from the top in relative importance among the nine school subjects normally available for high school boy students. Domestic science appears at the top of a list of eleven school subjects available for high school girls, although "science" as a pure subject was ninth out of eleven. Their judgements about the relative importance of school subjects indicate the feeling that science should play a significant role in the high school education of East Pakistan.

In contrast, high school science, under the existing program, has not produced desired outcomes in the individuals for satisfactory adjustments to various life situations. Findings from the questionnaire reveal that high school science education has been compartmentalized into the special sciences of physics, chemistry, biology, anatomy, and astronomy. It further reveals that science teaching has been mostly verbal, devoid of laboratory experiences and unrelated to everyday living.

To make science knowledge useful for everyday life, recommendations about new science courses, more trained teachers, and better facilities for laboratory work have

been made. It is recommended that science be made a compulsory subject toward the Matriculation Certificate. With particular attention to the needs of the pupils, and the cultural, social, and economic conditions of the country, an outline of a General Science course for grades six through eight has been proposed. Courses in physical and biological sciences have been proposed for pupils of the ninth and the tenth grades.

It is hoped that the findings and proposals of the present study will be of great help to the development of a detailed and adequate science program for all high school pupils of East Pakistan. It is hoped that the proposed program will lead to a better understanding of science, an increased appreciation of scientific achievements, and an ability to apply science learnings in practical everyday situations for the maximum benefit of the individual, his community and his country.

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CHAPTER I

INTRODUCTION

Need for this study. Science has made great achievements in modern times. Very often one hears that this is an "age of science". Books, newspapers and magazines are full of information about scientific discoveries and their applications.

These discoveries have exerted much influence on human life. The influence is mainly of two kinds. First, science has brought many changes in the modes of living of man. He is now enjoying better food and clothing, better housing and furniture, better transportation and communication facilities. He is enjoying improved medical services, more sanitary living conditions, less disease, and a better and longer life.

Further, science has influenced the ways of thinking of man. As a way of acting and thinking, science is an important aspect of modern life. Prejudiced and superstitious thinking in the field of material natural knowledge is, now-a-days, being replaced by scientific explanations to a large extent. Thunder is no longer believed to be the threatening of God against evil doings. It is now regarded as a natural phenomenon. In its effect on material benefits and on mental outlook, science has gained recognition as a factor in the advancement of modern civilization.

In spite of its tremendous importance, due attention has not been paid to science in the education of pupils in the high schools of East Pakistan. The First Five Year Plan for the development of the country is now in action. This program includes plans for education at all levels.[1] Reports for modification of the existing system of education have been published. In such reports special emphasis has been given to the technical education of high school pupils.[2]

But no attempt has yet been made to plan a helpful science program for the pupils in high schools. The system of science education which was framed by educators of the pre-partitioned Indo-Pakistan Sub-continent is still in practice. The present investigation will be an attempt to see some of the weaknesses in the existing high school science program and to suggest some modifications with a view to making scientific knowledge useful in everyday life.

The problem and its purpose. It is the high schools which produce the majority of the educated citizens of the country. At this level education prepares the pupils either for further education, or for their joining different professions such as agriculture, business, industry, government service, teaching, and so on. The high school occupies a very important position in the life of an educated citizen. The problem of the present study is to show what role science has in the high schools of East Pakistan in the preparation

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[1] Government of Pakistan, Planning Board, The First Five Year Plan, 1955-60, (Karachi, 1956), II, p. 400.

[2] Report of the Educational Reforms Commission, (East Pakistan, 1957), I, p. 23.

of the good citizen, and what science he should know at this level so that he can adjust himself well to different life situations. With these points in view the present study will be devoted to the fulfilment of the following purposes:

1. To show the relative importance of science among other subjects of the high school curriculum.
2. To indicate the role which science should play at the high school level in East Pakistan.
3. To examine the present practices in the system of science instruction at the high school level.
4. To recommend a program of new courses for the teaching of science in the high schools of East Pakistan.

Delimitations. The meaning of the word science is very vague and ambiguous. It involves a number of concepts which vary according to the viewpoints of individuals. "To some, it means knowledge, tested, controlled, and authoritatively approved. To others, it means freedom of inquiry and limitless discussion of ideas."[3]

Besides the common meaning of the term as "knowledge", science consists of subject matter and a method of investigation. According to Campbell, the subject-matter refers to different branches of science such as physics, chemistry, biology, astronomy, and the like. There are some branches which deal with living beings, such as zoology, botany, and physiology. There are other branches, like physics and chemistry, which consider non-living substances. All material objects are composed of these non-living substances. There are sciences which take one particular object into account,

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[3]Harrington Wells, Secondary Science Education, (New York, 1951), p. 33.

as geology deals with the particular object - earth; while another branch like astronomy deals with particular but similar objects - the heavenly bodies. Similarly, zoology, and botany consider animals and plants in the common name of biology.[4]

Physics, chemistry, biology, geology, and astronomy are all different branches of "pure sciences" which produce experts in their respective fields. But science in the high school is not aimed at producing experts. Here science is meant for all adolescent pupils. Possibly, some of them will be specialists in science in their adult life, while the majority will choose their professions in various other fields. Consequently, the definition of the word science for the present study will be confined to a limited aspect of scientific knowledge which is deemed useful for everyday living plus an understanding of the "scientific method" of dealing with problems.

Limitation with regard to high schools in East Pakistan. Details of the educational system of East Pakistan will be described in chapter II. It may be briefly noted here that middle schools, high schools, and Madrasahs are the three types of institutions that provide secondary education in East Pakistan. Middle schools terminate with the sixth class. In some cases, seventh and eighth classes are being added to middle schools to give rise to junior high schools. The high school proper extends up to the tenth class in addition to classes from the sixth to the eighth. Most high schools also have primary classes attached to them.

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[4]Norman Campbell, What is Science ? (New York, 1952), p. 14.

The Madrasah is predominant in religious instruction. In many respects it differes from general high school education.

Because of the recent emergence of junior high schools, the present study will include science education in junior high schools from the sixth to the eighth classes, and that in high schools from the sixth to the tenth classes.

Education is a provincial subject in Pakistan. Both the East and the West Pakistan Governments are responsible for education in their respective parts. They formulate their own educational policies according to the needs of their areas. The duty of the Central Government is only to coordinate the policies made by the two provincial governments. The medium of instruction in the high schools of West Pakistan is Urdu, while that in the high schools of East Pakistan is Bengali. The geographical and climatic conditions of the two parts are also such as to provide different scientific resources for the pupils.

With all these points in view, the present investigation has been limited to science education in the high schools (including the junior high schools) of East Pakistan only.

METHOD OF STUDY

The method of study proposed for the present investigation has emerged from the following procedures:

From a study of science textbooks, periodicals, magazines, and other available literature , the importance of science in everyday life has been examined. Contributions of science to modern living and its effects on human behavior have been described.

The importance of science education in the high schools of East Pakistan has been indicated by the judgements of sixty Pakistani University students as well as by its everyday use. These Pakistani students, registered in the American University of Beirut for the academic year 1957-58, responded to a questionnaire. Their opinions regarding the relative importance of school subjects, and hence, that of science in the school curriculum, suggests that a new era in the science education of high school pupils of East Pakistan is in the making. An attempt was also made, through the questionnaire, to get a picture of the existing science program including science courses, methods of instruction, science teachers, and the availability of laboratory facilities. The possession or the lack of a scientific point of view among these students, under the existing science program, was sampled.

An oral test was given to these students to test their understanding of everyday phenomena.

Based on all these findings, the current science program for the high schools of East Pakistan has been criticized, and new science courses have been recommended. Recent developments in the field of science teaching in other countries have received due consideration.

Finally, with the help of a number of science textbooks, an outline for proposed new science courses for the high schools of East Pakistan has been prepared. In the process, the needs of the country and the pupils' interests have been carefully considered.

CHAPTER II

THE EDUCATIONAL LADDER IN EAST PAKISTAN WITH SPECIAL REFERENCE TO SECONDARY EDUCATION

Purpose of this chapter. The educational system differs from country to country according to its type and organization. The purpose of this chapter is to give a picture of the educational ladder in East Pakistan. This will help in understanding the position of high school pupils in the whole of the educational system, and the directions they follow in science or in arts after completing secondary education. This chapter describes the educational system in East Pakistan from the pre-primary stage to the university stage with special reference to the secondary level.

PRE-PRIMARY AND PRIMARY EDUCATION

For pre-primary education the main necessity is women teachers. As there is no appreciable number of such teachers in the country, facilities for pre-primary education are very rare. It is only in Dacca, the capital town of East Pakistan, that there are a few Kindergarten schools for a limited number of children. There are some parents who provide home tutors for the pre-school education of their children. A tendency is now growing to attach a Kindergarten section to every primary school in both urban and suburban areas.

As pre-primary facilities are very rare, most of the children coming to the primary schools

have had no previous training.

Before the birth of Pakistan, primary education was designed for a period of four years. One of the resolutions of the Pakistan Education Conference of 1947 as quoted in the First Five Year Plan, 1955-60, is that "free and compulsory primary education be introduced for a period of five years, which should be gradually raised to eight years".[1] Since that time the East Pakistan Government has made some plans for compulsory primary education. The plan for compulsory education has been only partially undertaken by the government and is still in an experimental stage. But all primary schools have now been changed over to the five-year system from the earlier four-year system.

"Maktabs", which were the smallest teaching units in Muslim India before the days of British rule, continued their existence until the end of British rule in India. There are still a few existing in rural areas of East Pakistan, although government primary schools have mostly supplanted them. These institutions, mostly coeducational, are conducted in mosques, and have a religious bias.

Control of Primary education. The primary schools in East Pakistan are financed by the East Pakistan Government. Local cess[2] for the purpose is collected, but the

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[1] The First Five Year Plan, 1955-60, II, p. 403.

[2] Cess. This is a kind of tax imposed on the owners of land. A certain percentage of the land revenue is charged as cess which is spent for education of the local children.

N.B. Maktab is an educational institution in which children of the muslim community take their first lessons in religion. They learn how to read the Quoran in Arabic.

major share of the money comes from general revenues. There are some private agencies which contribute to many schools, but their number is small.

Of the total number of 25, 884 primary schools in East Pakistan, only 5,122 are compulsory schools[3] in which attendance of the local school-going children is obligatory. Education in the compulsory schools is free of school fees. But children have to pay for their books and other requirements such as medical care. The Directorate of Education has a separate administrative section which works with the assistance of the seventeen Inspectorates, one for each of the seventeen districts. Each Inspectorate is staffed with a District Inspector of Schools and his assistants. The compulsory primary schools are under the direct control of the District Inspector of Schools who appoints teachers and grants money.

The non-compulsory primary schools, where attendance of all children is not obligatory nor education is free of school fees, are conducted either by local agencies or by the District Boards. There are some schools which receive grants-in-aid from the government fund, while there are others which are financed purely by the District Boards. Teachers for the non-compulsory primary schools are appointed by the Board, but the appointment is subject to the approval of the District Inspector.

Primary school courses. The primary curriculum includes syllabuses of the following subjects.

1. Reading and writing of the mother tongue.
2. Arithmetic.
3. Urdu.

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[3]For details of the distribution of primary schools, see APPENDIX A.

4. Social studies, including history and geography.
5. Elements of science.
6. Physical training.
7. Religious instruction.

It should be noted here that in the primary curriculum, there is mention of science teaching. But to what extent the present science teaching at this level is effective has not yet been reported.

SECONDARY EDUCATION

Composition of secondary education. The types of institutions that conduct secondary education are: Middle Schools, Junior Schools, Madrasahs, and High Schools.

The Middle Schools include the primary classes and teach upto the sixth class. The number of such schools is rapidly decreasing, chiefly because the primary school has become a five-year school.

In some cases, the seventh and the eighth classes have been added to these Middle Schools, giving rise to Junior High Schools. Some of the Junior High Schools have evolved from the primary schools by gradual addition of the fifth to the eighth classes. Now Junior High Schools extend up to the eighth class, with primary classes attached to them.

Madrasah education at the secondary level is the continuation of the teaching in "Maktabs" at the primary stage. The Madrasah provides theological training for the pupils, given through the medium of either Arabic or Urdu. Besides these two languages, the Madrasah also teaches English, Bengali, Persian, history, geography, and Mathematics. There is no provision for teaching science in the

Madrasahs.

To what extend the present system of Madrasah education helps to produce properly trained religious leaders needs careful investigation.

High schools. After the primary level, the high school program consists of a period of five years. The high school invariably has the ninth and tenth classes in addition to the classes from six to eight.

There are some educators who look forward to the time when primary schools will continue to the eighth class, and high schools will go to the twelfth class. This will dispense with the Middle schools and the Intermediate classes in the colleges. From this point of view, the present structure of the secondary system is quite flexible. It provides for upgrading schools from primary to Middle, from Middle to Junior high, and from Junior high to Senior high schools.[4]

APPENDIX B indicates the distribution of secondary schools in East Pakistan. It may be noted that seventy-seven per cent of the entire secondary school population are high school and junior high school pupils. Of the total number of 1,535 high schools, only thirty-seven are run by the government, and the rest are mostly financed and conducted by local Managing Committees.

Control of secondary schools. The educational responsibility of the East Pakistan Government is discharged through a directorate of education which works under the

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[4]The Government of Pakistan, The First Five Year Plan, 1955-60, II, p. 408.

East Pakistan Ministry of Education. The chief administrative officer is the Director of Public Instruction. The Director and his staff of Range Inspectors supervise the district inspectorates, which are the basic administrative units. The Director, the Range Inspectors, and the District Inspectors are all supplied with staffs of Additional Directors or assistant inspectors as the case may be. The duties of all these staffs are primarily administrative.

Courses of studies. The following are the compulsory subjects for high school pupils:

1. English.
2. Major Vernacular (Bengali or Urdu).
3. Mathematics, including algebra, arithmetic, and geometry.
4. History, consisting of the History of Islam and the History of Indo-Pakistan.
5. Geography of the world.
6. Classical language (one of the following: Arabic Persian, Sanskrit, Pali, or Latin).

In addition to these subjects, science is a compulsory subject for all male students up to the eighth class. In the ninth and the tenth classes science is an optional subject. There is some differenciation in the selection of courses for boy and girl students in the ninth and tenth classes. While the boys study the courses mentioned above, the girls may study domestic science, which includes arithmetic and home economics, in place of mathematics. They may also substitute hygiene for the classical language.

In addition to these compulsory subjects, a student may study any one of the following additional subjects in the ninth and tenth classes:

Bengali (for those whose major vernacular is other than Bengali)
Urdu (for those whose major vernacular is other than Urdu)
Science
Health education
Public Administration
Additional mathematics
Commercial geography.

It may be noted here that not all high schools are allowed to teach science as an additional subject in the ninth and tenth classes. Thus the election of science, even as an additional subject, is limited to a small number of students.

Certificate. The East Pakistan Secondary Education Board determines the courses of study and conducts the examinations at the end of the secondary level. The final examination for the high school students is known as the Matriculation Examination and that for the Madrasah students is called the High Madrasah Examination. The Board awards the Matriculation Certificate to those who succesfully pass the Matriculation Examination and the High Madrasah Certificate to those who pass the High Madrasah Examination.

COLLEGIATE EDUCATION

Students obtaining the Matriculation Certificate are eligible for admission to colleges for further education. Colleges are mainly of two categories - Intermediate Colleges, and Degree Colleges, which are either government or non-government.

The Intermediate College provides education for two years in Arts and Sciences. In the whole of East Pakistan, there are twenty-two non-government Intermediate Colleges, of which only two offer science courses. Except for two Islamic Intermediate Colleges, whose courses are meant for theological training, there is no government Intermediate College.

The Degree College provides two years of intermediate courses and another two years of degree courses with the same management, buildings, and teaching staff. At present, there are thirty-seven Degree Colleges, of which ten offer science courses up to the degree of Bachelor of Science, and eleven up to Intermediate Sciences only.

Whether a student goes to an Intermediate College or a Degree College, he must pass the final Intermediate Examination, either in Arts or in Sciences, in order to pursue higher studies in the degree classes. If he passes the Intermediate Arts Examination, he is given the Intermediate Arts Certificate, and for the science course he receives the Intermediate Science Certificate. A student with the Intermediate Science certificate may join the degree courses either in Science or in Arts. But a student with the Intermediate Arts certificate may join only the degree courses in Arts, and not those in Sciences. On completing the courses of commerce at the Intermediate level, a student is eligible for the Intermediate Commerce certificate, and he may undertake his higher studies in the commerce courses only.

It should be noted here that of the total number of fifty-nine Intermediate and Degree colleges, only thirteen of them offer science courses. The selection of students

for admission to science courses is made on the basis of results of the Matriculation Examination. Only the first and second division Matriculates are allowed to elect science courses (if available) in the Intermediate classes. A third division student is almost never admitted to such a course.

Whether or not this sort of selection of students for Intermediate science courses is justified becomes a question when one reads the results of the final Intermediate Science Examination. Although only the most capable Matriculates, as judged by the results of the Matriculation Examination, are taken into science courses, approximately seventy per cent of them fail in the Intermediate Science Examination every year.

One of the reasons for the failure of such a high percentage of the better Matriculates may possibly be rooted at the secondary level. These students may be well versed in literature, law, political or social sciences, but their success in the Matriculation Examination in the first or in the second division does not necessarily mean that they will also possess high aptitude for sciences. Had there been science courses for all students at the secondary level, their admission to the Intermediate Science courses could have been made on the basis of their achievement in the science subjects. This possible relationship between the failure of the students in the Intermediate Science courses and the dearth of science courses at the secondary level needs, of course, further investigation.

After Intermediate, the Degree course extends from two to three years. One may join the Degree class either in "pass" or in "honours" courses. Two years of studies

are required for the pass course, while the honours course takes three years. The student graduates with the degree of Bachelor of Science (B.Sc.), Bachelor of Arts (B.A.), or Bachelor of Commerce (B. Com.).

Post-Graduate studies. After graduation, one may undertake his studies for the degree of Master of Arts (M. A.), Master of Science (M. Sc.), or Master of Commerce (M. Com.), as the case may be. The pass graduate is required to study for two years for his Master's degree, while an honours graduate may do his Master's degree in one year.

Summary. It may now be briefly stated that the educational ladder in East Pakistan has four main stages: The Primary stage for five years, the Secondary stage for five years, the Intermediate stage for two years, and the higher education level for two, three or four years. Secondary institutions such as the Junior High schools, the Madrasahs, and the High Schools produce the majority of the educated citizens of the country. The Intermediate stage gives a check to sending students to degree courses for higher education. After fourteen years of succesful studies, one may graduate with the Bachelor degree from either of East Pakistan's two universities, the University of Dacca, or the University of Rajsahi.

Students who intend to undertake professional science education in engineering or in medicine go to the Engineering or the Medical College after passing the Intermediate Science Examination. Those who intend to become lawyers require university graduation first and then may study a course in law. Prospective secondary school teachers join

teachers' training colleges after their graduation from the university.

The secondary schools, being at the crossroads where people are sent either out into private life or upward into further education, occupy a strategic position in the whole of the educational system. It has been mentioned that seventy-seven per cent of the secondary pupils of East Pakistan are taught in the high schools. The relationship between the lives of these pupils and the teaching of science at this level is an important one, and is treated in the following chapter.

CHAPTER III

THE RELATIONSHIP OF SCIENCE TO THE LIVES OF HIGH SCHOOL PUPILS

High school science for the terminal student. The education of more than three-fourths of the secondary pupils in East Pakistan is conducted in the junior high school and in the high school. But all these pupils cannot be expected to be able to go on to college for higher education. The student who is admitted to the sixth class, the beginning of the secondary level, has a number of alternatives. As education at this level is not compulsory for all boys and girls, the student may terminate his studies in any one of the sixth to the tenth classes. He may leave the school before or after completing the matriculation courses. If he is a student of the junior high school in a rural area, he will most likely terminate his formal education at the end of the eighth class. He may not have opportunities for continuing his studies in the ninth and the tenth classes in a high school. Even if he gets the chance, and completes the matriculation courses, he may be unsuccessful in the final examination, and thus discontinue further studies. Some of those who become matriculates will face insurmountable financial difficulties and be unable to go to college.

Whatever the reasons for termination of their studies, these people will try to find their places in the society.

A student who leaves high school in the early classes, or who does not succeed in the Matriculation Examination, most often joins in his family's work. If it is agricultural work, he will be required to cultivate his land and live on agricultural products. His economic efficiency will depend upon his agricultural output.

Such an individual can benefit much from some knowledge of science. Knowledge of the nature and composition of soil helps him in a better understanding of its management. If he is familiar with the classification of soils, he can select or modify the soil to fit a certain kind of crop. He can properly till the soil, and control its erosion. He will understand the fundamental purposes of tillage, such as preparation of a suitable seedbed, eliminating competition from weed growth, and improvement of the physical condition of the soil.[1]

The use of the fertilizers and manures is one of the common methods of increasing yields. If the terminal student knows the essential elements required for the production of a good crop, he can use suitable fertilizers at proper times. He will make use of commercial fertilizers available from a nearby agricultural centre, and conserve and use animal manures, green manures, and crop residues.

Besides soil management and the use of manures, his scientific knowledge will help in choosing the best environment, the best vegetables, and the best seeds to assure high yields and good quality. He will know that good seed is essential to successful crop production, and that bad

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[1]See, for example, John H. Martin, and Warren H. Leonard, Principles of Field Crop Production, (New York, 1957).

seeds are responsible for introducing weeds in the crop field, resulting in increased labor and reduced crop yields. His scientific knowledge may further help him to plan the improvement of vegetables through plant breeding.

But good production does not always ensure good consumption. Harvesting of crops and vegetables is followed by a period of time before they are consumed. During this period, changes take place in the food value of the stored crops. Scientific knowledge will help the farmer to select appropriate methods of storage, so that he will keep losses of preserved crops to a minimum.

Illustrations of this sort can be extended indefinitely to show the advantages of science courses for a terminal student going into agriculture. On the other hand, a student who does not study science will most probably follow the traditional methods which have been in use since time immemorial. He will not have the inquisitiveness to consult the local agricultural officer, who may be of great help to him in improving the local conditions, and giving help in matters of controlling plant diseases, insects, and weeds.

The establishment of good relationship between the farmer and the agriculture officer is an important aspect in agricultural improvements. The officer may be capable and enthusiastic, but because of the ignorance of the farmers and their traditional outlook, he is very often a failure in his mission. A farmer who has obtained some knowledge of science during his high school days will be a help to the officer in introducing modern applications of science in agriculture.

Science in health. As an educated person of a rural

community, the terminal student is responsible for maintaining his personal health, the health of his family, and of his community. His study of science will have familiarized him with the problems of good food, pure water supply, need for ventilation, and disposal of sewage.

The problem of health may be an immediately personal one, as in matters of diet. It may be a community concern, such as sewage disposal, or a pure water supply. Some knowledge of science will help the individual in determining what an adequate diet is, and when an individual or a family is well-fed. He knows how foods control growth, health, and general well-being. His scientific knowledge will help him to select and to eat food of adequate nutritional value. He will be able to prevent and detect malnutrition, which is the result of an inadequate diet. From science, he will know that foods furnish him energy, build and repair his body, and regulate the body processes.[2] So he will take particular care about producing or obtaining the required food for his family. In addition to his plant products, he will be concerned with livestock products, such as milk, butter, eggs, fish, meat, and poultry, and will know how to take care of the animals from which he derives his profit. He will feed his animals well and take the necessary measures for the preservation of their health.

With regard to community health, he can help people to understand how to insure a pure water supply. He may encourage his meighbors to maintain a reserve tank for drinking water which must be guarded against pollution.

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[2]For details see, A. O. Duncan, Food Processing, (Kingsport Press, Inc., 1951),p. 22.

In the matter of disposal of sewage, he may bring to the notice of the public the danger of spreading foecal matter in open places. As this practice very often affects community health, he will jointly work with other members of his community to arrange for proper disposal of sewage, and thus take measures against various contagious diseases.

His knowledge of science is especially helpful to him and to his community when there is an outbreak of an epidemic. The illiterate people still seek the help of the Fakir and the use of charms in an epidemic like cholera or smallpox. To tackle such situations, the educated person has the responsibility to popularize the preventive measures that can be taken against various diseases. In this respect, he can help the local public health officer by active co-operation in the program of inocculation, or vaccination of all children and adults. The support of an educated villager, particularly when such a program is conducted in a rural area, is a tremendous help to the preventive medicine agency.

The student who enters business after his high school education can profit by a knowledge of science. There is hardly any business activity which does not depend on the facts and processes of science for its efficient carrying-out. The businessman who is aware of the fundamental facts and principles of science is in a position to avoid costly errors and to adopt efficient measures in a tremendous variety of situations. For example, if he deals in food business, his knowledge of science will help him preserve the food materials from the action of harmful micro-organisms by heat, by refrigeration, by drying, and by addition of chemicals.

In the field of education, most of the primary school teachers are and will continue to be matriculates.

They may undertake some courses in teacher training after the matriculation, but this training period is so short that it must concentrate on teaching methods rather than on scientific knowledge. But such knowledge is a necessity for these teachers in arousing and sustaining children's interests. Children are full of whys and whats. Very often they ask questions which are related to natural phenomena and scientific discoveries. If the teacher lacks scientific knowledge, he cannot take advantage of a child's curiosity by providing a satisfactory answer at the right moment. Instead he may try to satisfy the child by answers based on superstition and prejudice.

The above illustrations indicate that a young man's role in the society, either before or after his completion of the matriculation courses, can be made more effective by high school science study. Science helps him in his personal matters as in food, health, and sanitation. It helps him in his family affairs, as in producing things, and earning money for the maintenance of his family. It helps him to play a significant role in maintaining community health and vigor. It helps him to replace superstitious beliefs by scientific truth. In short a knowledge of science arouses a general consciousness of and love for healthy and efficient living in modern society.

HIGH SCHOOL SCIENCE FOR THE COLLEGE PREPARATORY STUDENT

Students who successfully pass the Matriculation Examination and plan for higher education have two alternatives. They may join either the Intermediate Arts classes

or the Intermediate Science classes. As science courses are not taught in the Intermediate Arts program, students in this program receive no opportunity to become familiar with scientific phenomena. As a result, they remain as ignorant in scientific matters as the students who terminated their studies before or after the matriculation. Students joining the Arts program may become well versed in literature and social and political sciences, but their knowledge in the physical and biological branches of science remains scanty.

A political leader, a lawyer, or a public servant trained in the Intermediate Arts program cannot fully grasp the role that science plays in modern living. In preparing a developmental plan for the country, such a person cannot pay due attention to the scientific aspects of the plan. He may ask the advice of an expert, but ultimately, he follows blindly what someone else prescribes for him.

The student who has a special interest in science may plan for further studies in the Intermediate Science classes and advanced studies in the graduate and the post-graduate classes if he is given the opportunity to make such a plan at the secondary level. In the ninth and the tenth classes he may prepare his background in science for further studies in the following years. It may not be possible for a student to decide on his field of specialization, but a secondary science curriculum up to the tenth class can help him to decide in which branch of science he is mainly interested. Moreover, a good vocabulary in science is a prerequisite for continuing science courses at the college level. Without a sound understanding of the simpler concepts, a student often finds himself lost among the more complex concepts, laws, and principles.

Another type of student may intend to study medicine or engineering after his matriculation. Manifestly, this student also needs a background of scientific knowledge in order to undertake his studies in the selected field.

In conclusion, then, it can be stated without far of contradiction that an adequate aquaintance with science is an essential requirement in the secondary education program of East Pakistan, whether that education is to be terminal or college-preparatory. The next step therefore is to decide upon the objectives of such a course.

OBJECTIVES OF HIGH SCHOOL SCIENCE TEACHING

Functions of objectives. Science teaching can help in the modification of pupils' behavior. It can help them to increase the varieties of their adjustment patterns. But if science teaching is to be a means of helping pupils solve their adjustment problems, the problems and the methods of achieving them must be a part of daily work in the classroom. In preparing lesson plans in science, teachers must take into consideration the pupils' problems. Otherwise, objectives become a set of statements on paper only.

Various attempts have been made to formulate statements about the aims of science teaching. Some sources of such statements are textbook authors, curriculum workers, national committees, and articles in periodicals. Elwood D. Heiss and others have proposed a list of statements suggesting the various functions of such objectives. According to them, objectives of science teaching should:

1. Be directed toward the general goals of educa-

tion in a democracy.

2. Consider the needs and interests of the learner.
3. Serve as guide to the selection of learning materials.
4. Be attainable at a given level of instruction.
5. Serve as guides to the organization of learning materials.
6. Direct learning toward the modification of the behavior of the learner, that is, should be functional.
7. Serve to suggest ways of evaluation of progress toward their attainment.[3]

Keeping these guiding principles in mind, several statements of the objectives of high school science teaching were analysed to help in the determination of appropriate science-teaching objectives for the high schools in East Pakistan.

A synthesis of some statements of objectives. Statements of objectives made in various textbooks and periodicals were examined. In all, sixty-six statements were

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[3]Elwood D. Heiss, et. al., Modern Science Teaching, (New York, 1955), p. 25.

collected from eleven sources,[4] and classified into nineteen categories. The frequency of mention of each objective was determined by careful study of the original statements. The summary of the findings is presented in Table I, examination of which brings out the following main points: Much emphasis has been put on the development of pupil's interests. This received the most frequent mention in the statements examined. The development of the "scientific attitude" is the second most frequently-mentioned objective in Table I. Next comes the acquisition of knowledge in scientific facts and principles. Training in scientific method, and appreciation of the value and importance of

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[4] Eight of the eleven sources are quotations in Elwood and others' Modern Science Teaching from:

(i) Philiphine Crecelius, "A Report On the Objectives of General Science Teaching", School Science and Mathematics.
(ii) Ralph K. Watkins, "The Technique and Value of Project Teaching in General Science", General Science Quarterly.
(iii) Edward E. Cureton, "The Aim and Content of the Course of Study in General Science in the Junior High School".
(iv) W. C. Croxton, Science Teaching in the Elementary School.
(v) Glenn O. Blough, "Elementary Science Objectives", School Life.
(vi) Perry Winifred, Teacher's Handbook.
(vii) Beauchamph, W.L., et. al. Teacher's Guidebook for Everyday Problems in Science.
(viii) Otis W. Caldwess, Teacher's Manual for Everyday Science.

Other sources:

(ix) Victor Noll, The Teaching of Science in Elementary and Secondary Schools (Michigan State College Press, 1950), pp. 13-14.
(x) National Society for the Study of Education, The Forty-sixth Yearbook (Chicago, 1947), p. 22.
(xi) J. B. Kelley, "Science in the Junior High School", School Science and Mathematics, LVIII, No. 2, February, 1958.

TABLE I

MENTION OF VARIOUS OBJECTIVES OF SCIENCE TEACHING AS FOUND IN ELEVEN SOURCES

Objectives of Science Teaching	Frequency of Mention	Percentage of Mention
Developing interest in science.	12	13.33
Developing scientific attitude.	11	12.22
Acquisition of knowledge of scientific facts and principles.	8	8.89
Training in scientific method.	7	7.78
Appreciation of the value and importance of science.	7	7.78
Understanding and control of environment.	6	6.67
Acquaintance with simple applications of science in public utilities.	5	5.56
Broadening concepts, generalizations, and outlooks.	4	4.44
Inculcating critical thinking.	4	4.44
Opportunity for manipulation of toys, tools, machines etc.	4	4.44
Acquaintance with the laws of health.	4	4.44
Solving individual and community problems.	3	3.33
Developing habits of reading science content	3	3.33
Developing power of interpretation.	2	2.22
Information about nature and science.	2	2.22
Information about scientific appliances for better comfort and convenience.	2	2.22
Inculcating social attitude.	2	2.22
Preparation for later science courses.	2	2.22
	Total 90	99.97

science have received the next priority. There is mention of the understanding and control of the environment; acquaintance with simple applications of science; and broadening concepts, generalizations, and outlooks. Acquaintance with the laws of health was mentioned four times. Table I also indicates that science teaching should be aimed at inculcating critical thinking, and acquainting pupils with the techniques of solving individual and community problems. It should foster the habit of reading science content outside the usual routine work. Pupils should be informed about the applications of science which have made modern living comfortable and convenient. Preparation for later science courses is another objective indicated in Table I.

Proposed statement of objectives. The results of Table I indicate some of the areas which are most widely believed to need consideration in determining the objectives of science teaching. With these broad objectives, and with Pakistan's unique cultural, economic and educational climate in mind, the following proposed list of objectives for science teaching in the high schools of East Pakistan is submitted:

1. Helping pupils develop interests in science that will lead them to the satisfaction of achieving scientific knowledge.
2. Helping pupils develop scientific attitudes.
3. Helping pupils obtain knowledge and information about scientific facts, principles, and generalizations.
4. Training pupils in the scientific method of attacking their everyday problems.

5. Helping pupils better to understand and control their environment.

6. Developing appreciation of the value and importance of science, the contributions of scientists, the complexity of nature and the part science plays in understanding it.

7. Acquainting pupils with modes of healthful living for the individual as well as for his community.

8. Preparing pupils for later science courses which, in turn, may lead to their choice of a career in science or in a field related to science, such as agriculture, engineering, or medicine.

The above statements are not fundamentally different from those presented in Table I. Almost all the important objectives that appeared in the sources examined have been retained. The statements have been presented in accordance with the priority of mention that appeared in Table I. That the inclusion of these statements of objectives for high school science education in East Pakistan in justified will be clear from the following description:

Interest in science. Interest plays a great part in any area of learning. Activities that arouse interest are more fruitful in producing lasting outcomes than those attended by mere routine work. Particularty in science, there are many devices for creating and sustaining interest. According to Blair, adolescents are often interested in particular phases science for a career such as engineering, medicine, mining, or agriculture. Some of them have interests in photography, gardening, and making scientific

equipment.[5]

The high school science teacher in East Pakistan will, therefore, do well to consider this matter of pupils' interests. He should plan the learning experiences in such a way as to insure that pupils derive immediate satisfaction from them. At the same time, they will become interested in the subject, and this interest may continue on into adult life and even lead to a particular vocation.

Scientific attitudes. Table 1 shows that one of the major aims of science teaching should be the development of scientific attitudes.

In modern living, it is important that an average East Pakistani be able to apply a scientific point of view to the interpretation of natural phenomena. He should be accurate in operations like calculation, observation, and report. He should have the intellectual honesty to overcome personal bias and prejudice. He should develop the habit of admitting being wrong when proved so. He should develop an open-mindedness or willingness to consider new facts. Before coming to a conclusion, he should be able to judge all available data concerning a problem. This scientific attitude also involves the habit of criticism. He should listen to suggested explanations and proposed remedies of a situation with a critical mind. It involves the ability to criticize oneself.

That a person acquiring these habits develops a true scientific attitude has been described by Noll in the

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[5]Glenn Myers Blair, et. al., Educational Phychology, (New York, 1955), p. 76.

following statement:

> ... a person who habitually was accurate in his observations and report; who habitually looked for natural rather than supernatural causes in events; who did not jump to conclusions but was slow to generalize; whose habit it was like-wise to keep his mind open to new facts, data, and impressions, and to revise his conclusions; and finally who was honest in his evaluation of facts and not influenced by his personal bias and prejudice, and who had the habit of self-criticism - almost any one would admit that a man with all these habits of thought would be possessed not only of the scientific attitude, but also of a high degree of uniqueness.[6]

Elwood and others have described similar attitudes to which science can contribute. According to them, a science program should foster such attitudes as will modify the individual's behavior so that he will look for the natural causes for things that happen. He will not believe in superstitions, such as charms of good or bad luck. He will look for the universality of cause-and-effect relationships. He will be open-minded toward the work and opinions of others. He will base his conclusions upon evidence obtained from a variety of sources.[7]

Knowledge of science. It may be remembered that whether high school education is terminal or college-preparatory, the acquisition of a functional knowledge of science is of great importance. Pupils come across a number

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[6]Victor Noll, The Teaching of Science in Elementary and Secondary Schools, p. 26.

[7]Elwood, Modern Science Teaching, p. 89.

in their daily lives. Science instruction needs to be so planned and organized that pupils may use their knowledge in direct dealings in their daily lives.

The scientific method. The scientific method of adjustment to the physical world involves the examination of how things happen, and how something can be done about them. According to Elwood and others, it includes such elements as sensing a problem, defining the problem situation, studying the situation for all facts and figures, making hypothesis, testing the hypothesis, drawing conclusions, and finally verifying the results.[8] In the opinion of Sydney J. French,

> if there is anything unique in science it is the techniques that scientists have used so successfully to solve problems in science. If students can learn to understand and apply such techniques without having to become specialists, then science has something of first importance to contribute to general education.[9]

High school pupils will learn these techniques of scientific method by solving problems for themselves. Science will provide abundant opportunities for developing the skills of problem solving. But for this, they will need proper guidance for intelligent planning, careful observation, and experimentation. The findings of a problem in the classroom when applied to a new situation, will enable the pupil to understand the relationship between classroom activity and the real life problems. Thus, the development of the

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[8] Ibid. pp. 93-94.

[9] Cohen I. Bernard, and Fletcher G. Watson, eds., General Education in Science, (Harvard University Press, 1952), p. 31.

skills of problem solving is one of the major outcomes desired in the high school science program of East Pakistan.

Science for understanding the environment and for better adjustment. Present-day living is much more complex and chaotic than it was before. Enormous changes have been taking place in the physical environment. In these changing situations, the people of Pakistan are confronted with the problem of knowing the environment and adjusting themselves to the new situations created.

Science learning experiences can make a number of contributions to the adjustment of people. It can aid in the development of their social competencies. When trained in science, the individual is better able to handle scientific equipment, to explain natural phenomena by reference to their cause and effect relationships, and to develop a wider outlook on the changes that are going on in the world.

Appreciation in science. Science, as a body of tested laws and principles, is often intimately involved as a factor in stories of adventure, romance, and privation. Pupils should be encouraged to read such stories as will help them to develop an appreciation for the background from which science principles have been derived.

It may be noted here that an appreciation of anything comes from understanding. The understanding varies at different levels of instruction. In the early years of high school life, students are interested in stories of adventure and romance. Later on their interests shift as they read more. They begin to want to see how some of the

great scientists worked, what their problems were, and how they solved them. This interest, properly directed, may become a powerful motivating factor for science study at this level.[10]

The story of Davy and the discovery of the safety lamp, of Archemedes and the golden crown, may be used to show how scientists concentrate their thoughts to solve their problems. The fields of astronomy, physics, chemistry, biology all have interesting materials of this type which will help pupils develop appreciations for science.

Science for healthful living. Science can help in the development of the physical and the mental health of an individual. He can learn from the subject how to ensure good food and drink, and how to keep himself neat and tidy. He will know the laws of personal health as well as those of the community health. He will regularize his activities in such a way that he can maintain a healthy body.

Preparation for later science courses. Science can aid in the vocational guidance of pupils. An interested pupil can select his future courses in science, or in some particular vocation, if he has the opportunity to study the subject at the high school level. His discovery of an aptitude or interest in science will enable him to decide where he can fit himself best.

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[10]Elwood, et. al., Modern Science Teaching, (New York, 1955), p. 135.

RELATION OF SCIENCE OBJECTIVES TO THE OBJECTIVES OF EDUCATION

Growth toward the objectives of science instruction affects the learner's behavior in other situations, both in and out of school. At the same time, his experiences and observations outside the science class have a real bearing on his attitude toward life and his interest in science. It is necessary therefore, that the objectives in science education be correlated with the aims of education in general. A clear understanding of them will be of help to give effective teaching in science, and to promote growth in preparation for adolescent and adult life.

The Educational Reforms Commission of East Pakistan announces the functions of secondary schools as follows :

> The schools will produce young people who will be intelligently aware of the various problems confronting the country in social, economic and political spheres; ... They will be fitted to live as useful citizens of a democracy; they will have intelligent appreciation of the form of the country's government. ... The schools will create in them a thirst for further study not limited to the school days alone. They will produce people with high moral standards, people who have been trained to live healthy and happy lives, being respectfully conscious of the mutual rights and obligations in their social groups.[11]

This statement of secondary school objectives is in conformity with the general objectives of education as quoted by Crow and Crow from the Educational Policies Commission of the National Education Association. They have quoted the

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[11] Report of the Educational Reforms Commission, East Pakistan, 1957, I, p. 21.

objectives of education in four principal categories as follows:

1. The Objectives of Self-Realization
2. The Objectives of Human Relationship
3. The Objectives of Economic Efficiency
4. The Objectives of Civic Responsibility[12]

High school science education is closely related to the fulfilment of these objectives. Some of the concepts involved in self-realization can be easily developed through science teaching.

One of these concepts is that an educated person should understand the basic facts concerning health and disease. He should receive such instruction as will enable him to maintain bodiy vigor. He should know how to protect his own health, that of his dependents and of the community. High school science education takes care of meeting this responsibility by helping pupils to form health habits, by imparting health information, and developing a health consciousness. Another such concept of self-realization is that an educated person should be skilled in listening and observing. Techniques of science instruction provide opportunities for developing such skills.

Of the four principal objectives of education, probably the one most manifestly related to science teaching is "The Objectives of Economic Efficiency". By providing occupational information, assistance in occupational choice, and information relative to occupational efficiency, science helps an educated person to succeed in his chosen vocation.

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[12] Lester D. Crow, and Alice Crow, Introduction to Education, (New York, 1947), p. 54.

Knowledge of science, further, helps the pupil in the matter of consumership. Most goods and materials, at various points in their production, processing, and distribution have a direct connection with some phase of science. In the education of the consumer, science helps him to make wiser decisions about purchases, to improve his own production, and to make effective use of goods and services.

As for "The Objectives of Civic Responsibiltiy", science provides the educated person with critical judgement to defend himself against biased propaganda. He develops a regard for the conservation of national resources. All the basic concepts underlying conservation find their roots in the principles and meanings of science. Science deals with the origin and structure of soils, erosion and its control, conservation of forest goods, conservation of water power and other national resources. Above all, the educated person measures the value of science by its contribution to general welfare. To him, each contribution has a science-social significance for the individual, the community, and the nation as a whole.

The relationship of science to these various phases of life and to education itself is of great significance to the educational program of East Pakistan. To what extent it is realized by educated Pakistanis may be determined from a study of their judgements and feelings about science. Such a study was undertaken, and is reported in the next chapter.

CHAPTER IV

JUDGEMENT OF PAKISTANI STUDENTS ABOUT THE RELATIVE IMPORTANCE OF SCHOOL SUBJECTS

Sample of students. Sixty Pakistani students, who studied at the American University of Beirut during the academic year 1957-58, were asked to respond to the questionnaire shown in Appendix C. Eighteen of these students came from East Pakistan and forty-two of them came from West Pakistan. Of these sixty, forty-three were men and seventeen were women. In the questionnaire, everybody was requested to give his or her individual opinion with regard to the relative importance of different school subjects prescribed for the high school pupils of East Pakistan.

Administration of the questionnaire and its results. The questionnaire consisted of two lists of school subjects alphabetically arranged. The first was a list of nine subjects normally available for boy pupils. The second was a list of eleven subjects normally available for girl pupils. Each of the two lists was to be considered separately.

As for the "boys' list", each of the sixty student judges indicated his or her view about the importance of the various school subjects by putting a value "1" for that subject which the individual thought to be the most important of all among the nine. The one which he thought to be the second in importance was marked "2" and so on, until all the nine subjects were marked from 1 to 9.

The opinions of the sixty student judges were first classified into two groups, one of eighteen East Pakistani students, and the other of forty-two West Pakistani students. The total number of points for each of the school subjects in each group were calculated. This was done by adding up the points indicated by every individual against each subject. The subject which had the lowest number of total points was given a place-value or a rank in importance "1", and the one which had the highest number of points was given the rank "9". The results of these findings have been presented in Table II (a).

The relationship between the judgement of the East and West Pakistani groups was shown by a mathematical index. The Spearman Rank-Difference coefficient of correlation was calculated and showed the extent of agreement to be +.75.

The opinions about the same "boys' list" were further classified into another two groups, one of the forty-three male judges, and the other of seventeen female judges. The total points for each of the school subjects and the corresponding relative positions were determined.

The judgements of the male judges and the female judges have been presented in Table II (b). The relationship between the ranks of the school subjects in this case, as calculated by the Rank-Difference method was found to be +.83.

The list of subjects mentioned in the "girls' list" was given the same consideration. As the number of subjects in this list is eleven instead of nine, the judges marked the subjects from 1 to 11 according to their judgement of relative importance. Opinions of the judges were first

TABLE II (a)

JUDGEMENTS OF SIXTY PAKISTANI STUDENTS ABOUT THE RELATIVE IMPORTANCE OF SCHOOL SUBJECTS FOR BOY STUDENTS

Subjects	Judgements of East Pakistan group (18)		Judgements of West Pakistan group (42)		Judgements of Combined groups	
	Total Points	Rank in impor-tance	Total Points	Rank in impor-tance	Total Points	Rank in impor-tance
Classical language.	155	9	221	7	378	8
English.	78	4	176	3	254	2
Geography.	92	6	211	6	303	6
History.	100	7	233	8	333	7
Major Vernacular (Bengali or Urdu)	24	1	160	1	184	1
Mathematics.	72	3	196	4	268	4
Physical and Health Education	67	2	209	5	276	5
Public Administration.	132	8	296	9	428	9
Science.	85	5	174	2	259	3

TABLE II (b)

JUDGEMENTS OF SIXTY PAKISTANI STUDENTS ABOUT THE RELATIVE IMPORTANCE OF SCHOOL SUBJECTS FOR BOY STUDENTS

Subjects	Judgements of the Males (43)		Judgements of the Females (17)		Judgements of Combined groups	
	Total Points	Rank in importance	Total Points	Rank in importance	Total Points	Rank in importance
Classical language.	244	8	134	9	378	8
English.	193	3	61	2	254	2
Geography.	213	6	90	6	303	6
History.	227	7	106	7	333	7
Major Vernacular (Bengali or Urdu)	125	1	59	1	184	1
Mathematics.	196	4	72	4	268	4
Physical and Health Education.	208	5	68	3	276	5
Public Administration.	313	9	115	8	428	9
Science	183	2	88	5	259	3

grouped into those of the East Pakistani students and those of the West Pakistani students. Table III (a) shows the findings from these two groups about the girls' list of school subjects. The Rank-Difference coefficient of correlation between the judgements of East and West Pakistanis was found to be +.74.

Opinions about the girls' list were further classified into two groups. The forty-three male judges were used in one group, and the seventeen female judges were used in another group. The findings of these two groups have been show in Table III (b). The Rank-Difference coefficient of correlation between the findings of these two groups about the girls' list was found to be +.89.

The relative importance of school subjects, as judged by the entire group of sixty student judges, is shown in Table IV. In this table, the school subjects have been arranged in the order of judged importance. The most important subject, according to the collective opinion of the judges, has been placed at the top, and so on down to the least important one at the bottom.

Table IV shows that Bengali, the Major Vernacular of most of the high school pupils of East Pakistan, heads the list of school subjects for boy students. English is second in the list, and Science is third.

Domestic Science has come at the top of the list of subjects for girl students. The Major Vernacular occupies second place and Science comes ninth in the list of eleven subjects.

Interpretation of the results. The correlation of +.75 between the opinions of the East Pakistan group

TABLE III (a)

JUDGEMENTS OF SIXTY PAKISTANI STUDENTS ABOUT THE RELATIVE IMPORTANCE OF SCHOOL SUBJECTS FOR GIRL STUDENTS

Subjects	Judgements of East Pakistan group (18)		Judgements of West Pakistan group (42)		Judgements of Combined groups	
	Total Points	Rank in importance	Total Points	Rank in importance	Total Points	Rank in importance
Art and Handicraft.	88	4	201	3	289	3
Classical language.	156	10	242	6	398	8
Domestic Science.	47	2	134	1	181	1
English.	127	8	212	4	339	5
Geography.	109	5	277	8	386	7
History.	113	6	269	7	382	6
Major Vernacular (Bengali or Urdu)	25	1	193	2	218	2
Mathematics.	125	7	325	10	447	10
Physical and Health Education.	79	3	218	5	297	4
Public Administration.	178	11	402	11	580	11
Science.	131	9	297	9	428	9

TABLE III (b)

JUDGEMENTS OF SIXTY PAKISTANI STUDENTS ABOUT THE RELATIVE IMPORTANCE OF SCHOOL SUBJECTS FOR GIRL STUDENTS

Subjects	Judgements of the Males (43)		Judgements of the Females (17)		Judgements of Combined groups	
	Total Points	Rank in importance	Total Points	Rank in importance	Total Points	Rank in importance
Art and Handicraft.	207	3	82	4	289	3
Classical language.	278	7	120	7	398	8
Domestic Science.	142	1	39	1	181	1
English.	272	6	67	3	339	5
Geography.	280	8	106	6	386	7
History.	261	5	121	8	382	6
Major Vernacular (Bengali or Urdu)	153	2	65	2	218	2
Mathematics.	319	10	128	10	447	10
Physical and Health Education.	214	4	83	5	297	4
Public Administration.	218	11	162	11	580	11
Science.	302	9	126	9	428	9

TABLE IV

ARRANGEMENT OF SCHOOL SUBJECTS ACCORDING TO THEIR RELATIVE IMPORTANCE

List for Boy Students		List for Girl Students	
Number showing the Position	Subjects	Number showing the position	Subjects
1	Major Vernacular (Bengali or Urdu)	1	Domestic Science
2	English	2	Major Vernacular (Bengali or Urdu)
3	Science	3	Art and Handicraft
4	Mathematics	4	Physical and Health Education
5	Physical and Health Education	5	English
6	Geography	6	History
7	History	7	Geography
8	Classical language	8	Classical language
9	Public Administration	9	Science
		10	Mathematics
		11	Public Administration

and the West Pakistan group of student judges is a significant correlation.[1] The correlation of +.83 between the findings of the male students and the female students is also significant. This means that regardless of province or sex of these students, they agree substantially in their decisions as to the relative importance of school subjects mentioned for high school boys in East Pakistan. The same may be said for the judgements about the high school girls.

This significantly correlated relationship between judgements clearly indicate that the arrangement of subjects in Table IV can be reasonably accepted as representative of Pakistani students' opinion regardless of sex or province of origin.

The judges indicate that science has a significant role as a school subject for high school boys in East Pakistan. The place of domestic science at the top of the girls' list also indicates that the judges have shown their preference for the teaching of science in the form which can best serve the needs of the girl students of the country. Because domestic science includes some phases of everyday scientific knowledge, science as a separate subject for girl students has appeared at the ninth place among the eleven subjects arranged in Table IV. The place of domestic science at the top of the list and science at the ninth place further mean that everyday scientific knowledge of high school girl students can be adequately fostered if

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[1] Calculation shows that a correlation of this size would occur by chances only once in approximately sixteen such samples when the actual correlation in the population is assumed to be zero.

domestic science courses are carefully selected.

In short, the results of the judgements clearly indicate how science teaching should be emphasised in the educational program of East Pakistan. The next step is, therefore, to examine the science teaching practices in the high schools of the province.

CHAPTER V

DESCRIPTION AND ANALYSIS OF THE PRESENT SCIENCE TEACHING PRACTICES IN EAST PAKISTAN

Science teaching in East Pakistan since 1947. Pakistan inherited an educational system which was designed by the English before the achievement of its independence. The system may be suitable for producing office clerks, but it can no longer satisfy the needs of the citizens of an independent country. New educational plans are on the way for modification of the old system, but in practice progress has been very slow. This is particularly true in the teaching of science in the high schools of East Pakistan.

Science is still considered as a subject meant for the specialists. Officially it has been declared a compulsory subject for all students up to the eighth grade. A student who is specially interested in science can study it as an additional subject in the ninth and the tenth grades if his school offers such a course. Selection of content has been made from special sciences such as physics, chemistry, botany, physiology, anatomy, and astronomy. High school science text books, written in the mother tongue, include the content of these special sciences. Descriptions of different branches of science have been presented in different sections of the same text book. Students are supposed to commit to memory the scientific laws and principles so as to be able to reproduce them on paper

in the annual examination at the end of each year.

That science has certain relation to everyday living, that it can affect the behavior of people, has hardly been realized in planning the science curriculum. This will be made even clearer from the responses obtained from sixty Pakistani students of the American University of Beirut.

A fairly good picture of the existing science teaching practices in the high schools of East Pakistan was obtained by a questionnaire study made with the cooperation of these students. The questionnaire shown in Appendix D was prepared with a view to finding out the nature of science courses offered, methods of teaching used, availability of trained science teachers or laboratory facilities, and the attitudes of these students toward science. The questionnaire in Appendix E tested some basic knowledge of these Pakistani students regarding everyday scientific phenomena. The results obtained and their interpretations are set forth in this chapter.

Distribution of science courses. The questionnaire administered to these sixty university students from Pakistan revealed that sixteen of them had no opportunity to take courses in science during their primary and secondary education.

The other forty-four students (73.3 per cent of the group) studied science at various school levels.

Table V shows the grade levels where students took their beginning courses in science. It shows that beginning the study of science varies from the third grade to the tenth grade. About five percent of the students had their first course in science in the third grade, and two percent of

TABLE V

SCHOOL GRADES AT WHICH SCIENCE WAS FIRST STUDIED BY FORTY-FOUR PAKISTANI STUDENTS[a]

Grades where science was first given	Number of students who took science	Nearest integral percentage
III	2	5
IV	5	11
V	14	32
VI	9	20
VII	7	16
VIII	2	5
IX	4	9
X	1	2
	Total 44	Total 100

[a]Sixteen students out of sixty who responded to questionnaires did not study science at all.

them did not study the subject until they reached the ninth grade. The fifth grade had the highest percentage of students beginning a course in science.

Duration of the period of science study varies from student to student. Table VI shows that only thirty-two percent of these students had the opportunity to study science for six years, and thirty-six percent for five years. As low as two percent studied science only for one year in the whole of their school career.

Nature of science courses. An attempt was made to know the nature of the science courses studied by these sixty Pakistani students. The results are presented in Table VII. It shows that science courses in physics, chemistry, biology, physiology, anatomy, and astronomy have been studied by these students at different school grades.

It may be noted here that, in the present system of education in East Pakistan, the sixth grade is the beginning grade of the secondary schools. But because a good percentage of students begin their study in science in the fifth grade, as shown in Table V, inclusion of the fifth grade in Table VII shows the nature of continuation of courses in the sixth grade.

It is found that eleven percent of these students studied physics at the fifth grade, and fourteen percent of them at the sixth grade. The percentage of students taking physics increases gradually to the maximum of fifty-two in the ninth grade. The percentage in the tenth grade is lower than that in the ninth grade.

The course in chemistry had a similar beginning and an increasing percentage of students took chemistry until the

TABLE VI

DURATION OF PERIOD OF ELEMENTARY AND SECONDARY SCIENCE COURSES AS STUDIED BY FORTY-FOUR PAKISTANI STUDENTS

Duration of science study in years	Number of students	Nearest integral percentage
6	14	32
5	16	36
4	3	7
3	4	9
2	6	14
1	1	2
	Total 44	Total 100

TABLE VII

COURSES OF SCIENCE AS STUDIED BY FORTY-FOUR PAKISTANI STUDENTS AT DIFFERENT SCHOOL GRADES

Name of the courses	Percentage of students taking each course in several Grades					
	V	VI	VII	VIII	IX	X
Physics	11	14	25	27	52	50
Chemistry	11	11	21	21	46	43
Biology	14	5	7	7	22	2
Botany	0	0	0	0	0	0
Zoology	0	0	0	0	0	0
Physiology	0	5	11	18	25	25
Anatomy	0	5	5	11	18	14
Astronomy	0	0	0	2	5	5
Ather Courses	0	0	0	0	0	0

tenth grade. The maximum percentage of students taking that course, as in the case of physics, occurs in the ninth grade.

Some fourteen percent of the students studied biology in the fifth grade. But this percentage came down to five at the sixth grade with a slight increase in the seventh and the eighth grades. Then it again came down to two percent in the ninth and the tenth grades. There was no student who studied botany and zoology, as distinct from biology, in any one of the grades from the fifth to the tenth.

Physiology was studied by five percent of these students in the sixth grade. The percentage of students taking this course gradually increased to a maximum of twenty-five in the ninth and in the tenth grades. Some five percent of the students studied anatomy in the sixth and seventh grades. The percentage increased to eighteen in the ninth grade with a slight fall again in the tenth grade. Astronomy was studied by three percent of the students in the eighth grade with a little increase in number in the ninth and the tenth grades.

None of these students studied any science course other than those mentioned above.

SCIENCE TEACHERS, SCIENCE LABORATORY, AND METHODS OF TEACHING

Science teachers. The teaching of science in the high school requires that the teacher should know the subject. In the present investigation the Pakistani students reported that they were taught science by teachers of various

qualifications.[1] Table VIII shows that 68.2 per cent of the students who studied science were taught by teachers qualified both in the subject and in methods of teaching. About 22.7 per cent of the students were taught by teachers who knew science, but did not have any training in teaching. It is interesting to note here that 9.1 per cent of the students studied science with teachers who had neither any training in science nor any training in teaching.

Use of laboratory. Information in Table VIII about the use of the laboratory shows that 84.1 per cent of the science students had laboratory facilities and that the other 15.9 per cent had no laboratory in the schools where they studied. But only 68.2 per cent of the students made actual use of the laboratory themselves, although laboratory facilities were available in the schools of a much higher percentage of those students.

Methods used. The forty-four students who studied science courses gave their individual judgements about the approximate percentage of time devoted to the use of various methods of teaching science. Four principal methods were offered as choices and further mention of other methods, if they had experienced any, was invited. The findings are presented in Table IX, which shows that the lecture method

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[1] The estimates of these students about the trained or the non-trained teacher can be reliably accepted, because in the existing teacher-pupil relationship, a student knows his teacher by his qualifications rather than by his name. A university Science graduate is known to his students as "our B. Sc. teacher", while a trained teacher as "our B. T. teacher", and so on.

TABLE VIII

INFORMATION FROM FORTY-FOUR STUDENTS ABOUT SCIENCE TEACHERS AND USE OF SCIENCE LABORATORY

Information	Number	Percentage
SCIENCE TEACHERS		
Students taught by science teachers who had training in teaching methods.	30	68.2
Students taught by science teachers who did not have training in teaching methods.	10	22.7
Students taught science by teachers who studied neither a course in science nor a course in teacher training.	4	9.1
LABORATORY		
Students who had science laboratory in their high schools.	37	84.1
Students who did laboratory work themselves.	30	68.2
Students who did not have science laboratory in their high schools.	7	15.9
Students who did not do any laboratory work.	14	31.8

TABLE IX

METHODS USED IN TEACHING SCIENCE TO FORTY-FOUR PAKISTANI STUDENTS

Information	Average Percentage of Time
The teacher delivered lectures.	59.9
The teacher used materials to demonstrate the lesson to the class.	19.6
The teacher conducted field trips.	1.7
The teacher asked the student to observe, experiment with his own hands and draw inferences.	17.9
The teacher used other methods such as use of charts and models.	0.9
Total	100.0

is the most prevalent. The teacher uses the lecture 59.9 per cent of the total time devoted to science learning.

Next to the lecture method comes the demonstration method, in which the teacher himself does some experimentation in front of a class. Students merely watch the performances of the teacher. They are supposed to learn the techniques of doing the experiment as the teacher does.

Direct observation and experimentation by students is done only 17.9 per cent of the total time devoted to science learning. Activities in science learning outside the classroom are rather negligible. Only 1.7 per cent of times field trips or excurtions were conducted. Use of charts, models, or any other visual aids is still less. Very little mention was made of such means.

Feelings toward scientific news. Table X shows that there was none among these students who was disinterested in scientific information. But 20 per cent of them expressed neutral feelings about such news. They neither disregarded it nor showed any interest. About 65 per cent of these students expressed their positive interest in reading science news. Only 15 per cent of them claimed to be "very much interested" in scientific news.

Feelings about superstitious beliefs. There are many superstitious beliefs prevalent among the illiterate mass of the country. Some of them are as follows:

To wink the upper eyelid of the right eye is an indication that bad news will follow such as the death of a near relative, or some misfortune. To see a fox on the left hand side of the road means a happy journey.

TABLE X

FEELINGS OF SIXTY PAKISTANI STUDENTS ABOUT SCIENTIFIC NEWS

Information	Number	Percentage
Those who feel "disinterested" in scientific news.	0	0.0
Those who feel "neutral" about scientific news.	12	20.0
Those who feel "interested" in scientific news.	39	65.0
Those who feel "very much interested" in Scientific news.	9	15.0

If somebody sneezes behind a person who has just started on a journey, it will cause misfortune or failure of the purpose of the journey. The calling of an owl at midnight indicates the visit of an evil spirit which will cause the out-break of an epidemic. Cutting hair on Tuesday causes financial loss to a business man. Admission to an educational institution on Thursday morning is good, but that on Saturday is bad. An expectant mother must not move during an eclipse, lest the baby in her womb become physically defective. Illustrations of such superstitions are numerous.

Some of the illiterate people are very often guided by such beliefs and they try to influence others. In an attempt to know the opinions of the university students about such beliefs, it was found that none of these sixty students believed in superstitions. But only 58.3 per cent of them, as revealed in Table XI, indicated their intention to seek scientific explanations for or against such beliefs. The other 41.7 per cent of them expressed an attitude of avoidance of such matters. They were not willing to find any cause-and-effect relationship in the beliefs often held by illiterate people.

Observable natural phenomena. A clear blue sky, a cloudy or a rainy day, a colorful sky during sunrise or sunset, a gentle breeze in the morning or a storm in the afternoon, a thunderstrike on a rainy day, and so on, are some of many natural phenomena which attract human interests.

The attitudes of the Pakistani students with regard to such phenomena were investigated. About 63.3 per cent of these students, as indicated in Table XII, on page 63, replied that they wanted scientific explanations for such

TABLE XI

SCIENCE FOR COMBATING SUPERSTITIOUS BELIEFS

Information	Number	Percentage
Those who seek scientific explanations for superstitious beliefs.	35	58.3
Those who ignore superstitious beliefs and do not seek scientific explanations.	25	41.7

TABLE XII

INQUISITIVENESS OF SIXTY PAKISTANI STUDENTS ABOUT SCIENTIFIC PHENOMENA

Information	Number	Percentage
Those who seek for scientific explanations for observable natural phenomena.	38	63.3
Those who think that seeking scientific explanations for observable natural phenomena is the scientist's job.	22	36.7

occurrences. The rest of the students, about 36.7 per cent, thought that it was the business of the scientists to give explanations for them. In the opinion of the latter group. a phenomenon related to scientific knowledge should properly concern the scientists only.

Handling of everyday scientific devices. In modern living, man makes use of many scientific devices for his comfort and convenience. One becomes acquainted with the use of radios, telephones, toilets, and elevators either by handling them, studying about them, or both. Those who have made very little use of such devices and have not studied about them are likely to feel awkward in using them. Some people, through practice, may feel easy in operating these devices, and confident in their use.

In an inquiry about the Pakistani students' feelings in handling these everyday scientific devices, some 15 per cent of them replied that they felt awkward, and 46.7 per cent felt easy. Only 28.3 per cent of these students reported that they felt confident in the use of such devices. The results have been presented in Table XIII.

A TEST OF SCIENTIFIC KNOWLEDGE OF SIXTY PAKISTANI STUDENTS

A set of thirty questions related to scientific phenomena and to everyday experiences was framed to test the scientific knowledge of the sixty Pakistani students. The test was designed to know to what extent the present practices in science teaching help pupils to acquire everyday scientific knowledge. It was conducted by means of structu-

TABLE XIII

FEELINGS OF SIXTY PAKISTANI STUDENTS IN HANDLING ORDINARY SCIENTIFIC EQUIPMENTS

Information	Number	Percentage
Those who feel "awkward" in handling ordinary equipments.	15	25.0
Those who feel "easy" in handling ordinary equipments.	28	46.7
Those who feel "confident" in handling ordinary equipments.	17	28.3

red individual interviews.

The questions for the test are shown in Appendix E. Appendix F shows the answers to the questions. Statements in parentheses in Appendix F were not required as essential parts of a student's answer, although some of them were able to give the details. For example, if one could say that air consists of oxygen, nitrogen, carbon dioxide, and contains water vapor and solid particles, his answer to the question, "what substances are found in air?", was accepted as correct answer. It was not a requirement that he should also know the names of other rare gases such as, argon, helium, krypton, and neon.

If a student could verbally give the correct answer to a question, the symbol "p" representing a pass was encircled. In case of a failure, "m" representing a minus for a wrong answer or a lack of response was encircled.

Every student was then given a total score according to the number of p's he or she obtained in the whole test. The student who had answered correctly all the thirty questions had thirty p's or a total score of 30, one "p" corresponding to one score point. If he would had ten m's, and twenty p's his score was 20.

Analysis of the test results. The scores of the sixty students have been presented in Table XIV in a frequency distribution. The average score obtained was 15.3 points with a range from score 5 to score 30.

It may be noted here that the test was deliberately constructed so that the information for all thirty questions could be expected to be acquired in a first-year general science course. This set of questions is only a sample of

TABLE XIV

SCORES OF SIXTY PAKISTANI STUDENTS ON A TEST OF SCIENTIFIC KNOWLEDGE

(FREQUENCY DISTRIBUTION MADE IN INTERVALS OF THREE UNITS)

Score	Frequency
28 - 30	3
25 - 27	4
22 - 24	4
19 - 21	5
16 - 18	10
13 - 15	12
10 - 12	10
7 - 9	8
4 - 6	4

Mean = 15.3

Median = 14.5

Standard Deviation = 6.4

more important elementary general science knowledge. It is to be expected that a high school matriculate should be fully acquainted with the simple phenomena involved.

The result of the test shows that the mean score of this group of students for this specific test is 15.3, and the median is only 14.5.

The difference between the mean and the median indicates that there is a noticeable positive skewness in the distribution. In other words, there is a piling up of scores below the median, and a tail running up into the high scores. Thus, most of the students have scores lower than the mean of 15.3, and only a few of them have high scores at and near the maximum of 30.

These results clearly indicate serious deficiencies in the knowledge of these students concerning everyday scientific phenomena.

GENERAL DISCUSSION

The findings stated in the foregoing pages of this chapter give a picture of the nature of the organization of science education in the high schools of East Pakistan. The findings in Table VII and Table VIII indicate the nature of science courses offered to school students, and the arrangement of those courses to different school grades. Table VII indicates that the organization of science teaching has been along the lines of special sciences such as physics, chemistry, biology, astronomy, physiology, and anatomy.

But in offering these courses, schools do not seem to maintain a common standard. This is evident from the

results of Table V, on page 51. It shows serious lack of uniformity in, and continuation of the courses. While some students begin a course in the third grade, others may begin a course as late as in the ninth grade without any background knowledge in the lower grades. The fifth grade has been most frequently mentioned as the grade where students took their beginning course in science. The content of science, even in the fifth grade, was selected from such courses as physics, chemistry, and biology. These courses have been continued through the tenth grade with the addition of other branches of special sciences.

Table VI, on page 53, shows the variations in the periods of studying science. While some students studied science for six years before they completed their secondary school education, there were others who could study such a course for one year, not to mention those who were earlier shown to have studied no science at all. This causes a heterogeneous result in the quality of pupils' science knowledge. For example, if one of two students of the same ability studies science for five years while the other studies it for only one year, these two students will differ greatly in their scientific knowledge even though they complete the matriculation courses in the same year. The maintenance of even a resemblance of a standard in science education requires that science offerings and requirements be made more uniform throughout the country.

Besides, the teaching of special sciences in all the grades of high schools is psychologically unsound. All students cannot be expected to be specialists in science. All students are not equally interested in the same branches of science. It is of little value to teach a student

at the secondary level how to dissect a human body, or to teach him the theories of physiological functions, when he could benefit far more by knowing some general rules on how to maintain good health. It is not sound to require a secondary student to memorize scientific laws and principles without understanding how they are related to his everyday problems. Instead, courses should be so organized as to be of use to all high school pupils, whether they are to become specialists or not.

The findings in relation to the methods of teaching science indicate that the science teacher uses the lecture most frequently as a means of his instruction. Of the four principal methods, mentioned in Table VIII, on page 57, the field trip is an effective way of arousing pupil's interest in science learning and in relating their learning to everyday experiences. But results show that there is almost negligible mention of the use of the field trip in science teaching in the high schools of Pakistan.

It has also been shown that there are some students who studied science with teachers who had knowledge neither in science nor in teaching methods. Science teaching given by those teachers is sure to be mostly verbal, and centered around the textbook. Such teachers may have attempted to explain to the students the contents of the textbook, but they could hardly be expected to show the relationship of the textbook knowledge to the real world around it.

Investigation about the attitudes of these Pakistani students toward superstitious beliefs and scientific explanation for common natural phenomena reveals that they lack in inquisitiveness about science and do not realize its values in providing explanations for many unfounded beliefs.

It may be mentioned here that in science teaching

> The main and basic outcome is the acquisition of a fund of knowledge of facts and principles, and how to apply them, i. e., to acquire the ability to select the right principle or principles in right sequence which apply to the solution of a given problem. ... The acquisition of a fund of knowledge of facts and principles is more fundamental, as it is the means by which we arrive at the knowledge of method. To apply science to our problems we must posses a fund of knowledge...[2]

That the desired outcomes of science teaching have not been achieved by these university students is evident from their poor knowledge in everyday science, Their deficiencies in scientific knowledge indicated by the test results, in turn, are also responsible for the lack of their satisfactory adjustment to certain situations. This is clear from the findings that some of the students still feel awkward in using everday scientific devices such as radios, telephones, toilets, and elivators. Products of science are sometimes miracles to their understanding and do not make for a comfortable approach to modern living.

But there is a point of contrast. Although these students themselves are not adequately educated in science, they feel the necessity of science teaching in the high school and realize the tremendous effect of science on modern living. This is evident from their judgements about the relative importance of school subjects. In the opinion of the group, science should have a prominent role in the

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[2]Emile Dumit, Aims of Science Teaching in a General Liberal Education, Mimeographed Notes, (Education Department, A. U. B., 1958), p. 4.

education of high school pupils.

Considering the weaknesses of the existing science program in the high schools of East Pakistan, and at the same time, its importance for modern living, it becomes clear that the present science program needs modification and improvement toward producing better educated citizens.

It is appropriate to mention here that much emphasis has been put on the teaching of high school science in a technologically advanced country like the Union of Soviet Socialist Republics. Reports show that about 42.4 per cent of school time is devoted to sciences and related technical training before graduation from Soviet 10-year primary-secondary schools.[3] Decrees on education in the Republics clearly state that graduates from the 10-year schools must possess scientific knowledge of everyday life, and be able to solve simple industrial and agricultural problems.[4]

RECOMMENDATIONS

On the basis of the above description the following recommendations can be made for a better science program in the high schools of East Pakistan:

1. Special courses of science, as given in various grades of some high schools of East Pakistan at present,

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[3]Division of International Education, Education in the USSR, Bulletin 1957, No. 14 (Washington 25, D. C., 1957), p. 67.

[4]Ibid., p. 91.

should be replaced by a required course in General Science for all boys and girls from grades six through eight.

2. All ninth and tenth grade pupils of boys' high schools should be given courses in physical sciences and general biology (a fusion of botany, zoology, and physiology).

3. The domestic science course for all ninth and tenth grade pupils of the girls' high schools should be revised and made more science biased. The elementary arithmetic part of this subject should be replaced by contents of physical and biological sciences.

4. High school science textbooks should be revised to stress everyday scientific knowledge. Textbook knowledge should be supplemented by additional readings such as stories and accounts of discoveries in science.

5. Provision for more trained science teachers should be made by encouraging the non-trained science graduates to undergo training in teacher training colleges. Each high school should be asked to provide better laboratory facilities for the pupils.

6. The election of science as an additional subject should be abolished; instead it should be made a compulsory subject for the Matriculation Certificate. This compulsory science sequence has been suggested in sections(2) and (3) above.

Further investigations about detailed science content for all high school pupils, trained science teachers, suitable textbooks, and laboratory facilities will be needed for the improvement of the science program in the high schools of East Pakistan. As such an extensive investigation is not within the limits of the present study, the

following chapter will propose only an outline of General Science courses recommended for all boys and girls from grades six through eight.

CHAPTER VI

AN OUTLINE OF PROPOSED GENERAL SCIENCE COURSES FOR THE SIXTH THROUGH THE EIGHTH GRADE PUPILS OF EAST PAKISTAN

What is General Science? The term "science" refers to a unity. It is more than a collection of various sciences. General Science is such an organization of different branches of science as will give an idea about this unity of scientific knowledge. It gives the pupil an opportunity to realize this oneness. Noll describes that it " ... purports to be an integration and an over-view of the whole field of natural science."[1]

According to Saunders, General Science is a course which provides sufficient information for the pupil to appreciate the application of scientific methods. It draws attention to the vast field of science. It tries to present science as a whole. This is contrary to the restriction of a pupil to one or more specialist sciences which do not provide the kind of integrated outlook which General Science does.[2] Saunders makes a recommendation concerning General Science as follows:

> "When a child begins his school career at the age of six, then between the ages of eleven and fourteen, and for a period of not less than

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[1] Victor Noll, The Teaching of Science in Elementary and Secondary Schools, p. 144.

[2] H. Saunders, The Teaching of General Science in Tropical Secondary Schools (London, 1955), p. 15.

> three years, he should follow a General Science course.[3]

He further states that such a study develops in the pupil the ability to solve problems which are susceptible to scientific treatment. It develops a scientific attitude toward life and its problems. It furnishes an introduction to the major branches of science. It makes the pupil acquainted with the whole field of science to the extent that he may determine in which branch or branches he may later desire to do more specialized work. This course introduces the pupil to most of the general underlying principles which scientists have discovered so far.[4]

General Science and the traditional science subjects. The distinction between General Science content and that of the traditional science subject is that in the former, the same lesson may include knowledge of different sciences. Whatever items are chosen for inclusion in General Science, they will be taken up later on in more detail in the study of the specialized sciences. They will re-appear under the headings, physics, chemistry, botany, and so on. But the main theme of General Science is that, at the beginning, these divisions are ignored. Its approach is to put aside all such divisions. It begins with the most fundamental aspects of a scientific phenomenon which is then expanded to the limit of the maturity level of the pupil.

Selection of subject-matter in General Science.

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[3] Ibid.

[4] Ibid. p. 16-17.

Saunders suggests that the following points should be taken into account in determining the content of General Science. The material for General Science must be:

(a) fundamental:
(b) related to the needs of the community;
(c) related to the subsequent career of the pupil;
(d) suitable for teaching
    (i) appropriate to the pupil's intellectual development, temperament, needs and interests,
    (ii) related to the pupil's environment.[5]

When science content is selected with these principles in view, the next task is the organization of the subject-matter. The following statements may be cited as guiding principles for organizing the content materials of General Science. These statements have been taken in condensed form from some of the recommendations made by the National Society for the Study of Education:

1. The General Science courses shall be organized into units. Each unit shall be related to some significant aspect of the environment.

2. The unit shall be related to a problem of everyday life to which science may contribute to a better adjustment of the pupil.

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

4. The organization of the materials shall be partly in the form of problems or projects to insure education in problem-solving.

5. As far as practicable, the units and their study

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[5]Saunders, op. cit., p. 24.

materials shall be so arranged and organized that the succeeding units will call for the understanding of greater relationships among them. They shall also contain increasingly difficult activities and be more and more comprehensive.

6. The entire set of units shall be so formulated that the pupil will realize the kind and nature of each of the major fields of science.

7. The materials and activities shall be organized, as far as possible, around the pupil's life, but should also project the pupil into the problems of adulthood.

8. The organization of the materials should be so as to lead the pupil to the attainment of the immediate and ultimate objectives.[6]

It is expected that at least three types of workers will cooperate to build a detailed science program. The first type constitutes the subject-matter specialists. They can insure that the materials to be included in the course are accurate and up-to-date. The second type consists of classroom teachers and headmasters. They are in a position to refine the materials in the light of their appropriateness of content and difficulty. The third group consists of specialists in the teaching of science who possess a knowledge of educational research in this field.

The program outlined below is a tentative one. It makes room for suggestions from the experts. As the basis of this outline, the areas of General Science content suggested by the Bureau of Secondary Curriculum Development, New York State Education Department, have been found useful.

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[6]National Society for the Study of Education, "Program for Teaching Science", Thirty-first Yearbook, Part I, (Chicago, 1932), p. 208-11.

The Bureau has organized the General Science courses around ten major areas which are as follows:

1. Kinds of Living Things.
2. Keeping Healthy.
3. Using Electricity.
4. Lifting and Moving Things.
5. Common Chemical Changes.
6. Energy from the Sun.
7. The Atmosphere.
8. The Earth and Sky.
9. Rocks and Soil.
10. Survival of Living Things.[7]

These areas of General Science course study have been partially developed into units and problems in the proposed outline. The problems have been cited as mere illustrations for developing the detailed program through more problems. The suggested topics have not been differentiated for pupils of the sixth through the eighth grades. The differentiation of the topics according to the maturity levels of the students leaves room for further considerations.

PROPOSED OUTLINE OF GENERAL SCIENCE TOPICS

The following is the proposed outline for General Science course for the lower three grades of the high schools of East Pakistan. Its units and problems have been selected

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[7] Bureau of Secondary Curriculum Development, Science, 7-8-9, (New York, 1956), p. 21-32.

with the help of several science textbooks[8] with special attention to the needs, and social, cultural, and economic conditions of the high school pupils of East Pakistan. The outline has been prepared around the ten major areas suggested by the Bureau of Secondary curriculum Development.

Area I. KINDS OF LIVING THINGS.

Unit one. The Most Familiar Living Things.

Problem:- Questions

(a) What are living things like?

(b) What are some important characteristics of the living materials?

(c) What are the structures, habits, and uses of plants?

(d) How are the forms and growth habits of green plants related to photosynthesis?

Unit Two. Some Important Animals.

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[8] Some of the sources are as follows:

(i) Ira C. Davis, and Richard W. Sharpe, Science, A Story of Discovery and Progress (New York, 1947).

(ii) John A. Clark, et. al., Science on the March (Boston, 1946).

(iii) Bureau of Secondary Curriculum Development, Science, 7-8-9 (New York, 1956)

(iv) H. N. Saunders, The Teaching of General Science in Tropical Secondary Schools (London, 1955).

(v) Carpenter & Wood, Our Environment, parts I, II, & III, (Boston).

(vi) Sherwood F. Taylor, General Science for Schools, parts I, II, & III (London).

Problem-Questions :

(a) How do some insects help or harm man? (Mosquitto, Bedbug, Cockroach, Beetle, Grasshopper, House fly, Bees.)

(b) How do some birds help or harm man?

(c) How do some domesticated and wild animals help or harm man?

Unit Three. Problems of Living Things.

Problem-Questions :

(a) What are the needs of living things?

(b) How do living things affect each other?

(c) What are the habitats of living things?

Unit Four. The Relationship of Man to Other Living Things.

Problem-Questions :

(a) How does man change his environment?

(b) How does man make use of living things?

(c) How is man affected by living things?

Area II. KEEPING HEALTHY

Unit One. Nature of the Human Body.

Problem-Questions :

(a) What is the structure of the human body?

(b) What are the main systems and organs of the human body?

(c) What are the main functions of the chief organs?

Unit Two. Sources of Food.

Problem-Questions :

(a) From what sources does man obtain his foods?

(b) How are foods used by green plants?
(c) How do nongreen plants and animals obtain food and energy?

Unit Three. Food Supply to Every Part of the Body.
Problem - Questions :

(a) What are the main structures of the human digestive system?
(b) How are foods digested and absorbed?
(c) How are foods and oxygen carried to the cells of the human body?

Unit Four. Body Cells Use Foods for Many Purposes.
Problem - Questions :

(a) How does an animal cell use food for energy?
(b) How are waste products discharged from the human body?
(c) What is a balanced diet?

Unit Five. Water is Essential for All Living Things.
Problem - Questions :

(a) What is water, a chemical coumpound or a mixture?
(b) What are some important properties of water?
(c) What is the water cycle?

Unit Six. A Safe Water Supply is Important.
Problem - Questions :

(a) How do living organisms obtain water?
(b) What are the sources of water supply?
(c) How is water supplied in villages?

(d) How is water supplied in towns?

Unit Seven. Water is Necessary for Many Purposes.

Problem - Questions :

(a) What is water pressure and how does it act?

(b) How is running water used in doing work?

(c) How is water used in cleaning things?

Unit Eight. Health and Diseases.

Problem - Questions :

(a) What has science done in combating diseases?

(b) How are insects related to diseases?

(c) How do common diseases spread?

Unit Nine. Prevention and Control of Diseases and Injuries.

Problem - Questions :

(a) What are some good health rules?

(b) How may personal health be guarded?

(c) How may community health be guarded?

(d) What first-aid measures should be taken in common emergencies?

Area III. USING ELECTRICITY

Unit One. A Magnetic Field.

Problem - Questions :

(a) What are some important characteristics of magnetism?

(b) What is the earth's magnetism?

(c) What are the uses of compasses?

Unit Two. Getting Acquainted With Electric Current.

Problem - Questions :

(a) What are some important characteristics of electric currents?

(b) How do electric cells furnish currents?

(c) What is the relation between magnetism and electricity?

Unit Three. Electricity in Use.

Problem - Questions :

(a) How does a knowledge of lightning enable man to protect himself against it?

(b) How is electricity used in the home?

(c) How is electricity brought into the home?

Unit Four. Electricity in Communication.

Problem - Questions :

(a) How does sound travel?

(b) How are the telegraph and the telephone used in communication?

(c) How is communication effected through radio?

Area IV. LIFTING AND MOVING THINGS

Unit One. Use of Energy through Machines.

Problem - Questions :

(a) What are the chief reasons for using machines?

(b) How is the work done by a person or a machine measured?

(c) How do levers help work?

(d) Why are pulleys useful?

Unit Two. Simple Machines are Widely Used.

Problem- Questions :

(a) How is a wheel and axle used?

(b) How are inclined planes used?

(c) How and why are wedges used?

Unit Three. Machines in Transportation.

Problem- Questions :

(a) What are some important applications of science to transportation on land?

(b) What are some important applications of science to transportation on water?

(c) What are some important applications of science to transportation in air?

Area V. COMMON CHEMICAL CHANGES

Unit One. Matter and Its Change.

Problem - Questions :

(a) What is matter, and how does it change?

(b) What are elements, mixtures, and compounds?

(c) What are atoms and molecules?

Unit Two. Useful Gases.

Problem - Questions :

(a) Why is oxygen an important element?

(b) Of what importance is the most abundant constituent of the atmosphere?

(c) What are some of the properties of hydrogen?

Unit Three. Acids, Bases, and Salts.

Problem-Questions :

(a) What are acids, and what are their physical properties?

(b) What are most common bases? What are the characteristics of bases?

(c) What are the properties of salts? How are they prepared and named?

Area VI. ENERGY FROM THE SUN

Unit One. Energy Comes from the Sun.

Problem-Questions :

(a) How is the air warmed by the sun?

(b) How is the energy of the wind used?

(c) How does sunlight produce water power?

(d) How does man get energy to run machines?

Unit Two. Light and Its Use.

Problem-Questions :

(a) What are some important characteristics of light?

(b) How are light rays affected when passed through glass or water?

(c) How is the home lighted?

(d) What does man need to know about color?

Unit Three. Seeing an Object.

Problem-Questions :

(a) How are images formed with lenses?

(b) How are pictures taken in a camera?

(c) How does the eye see things?

Unit Four. Heat and Temperature.

Problem-Questions :

(a) What are the sources of heat?

(b) What are some of the important characteristics of heat?

(c) What are heat and temperature?

Unit Five. Using Heat from Fuels.

Problem-Questions :

(a) What does man need to know about fire?

(b) What are the relative values of various kinds of fuels?

(c) What are some modern means of fire prevention?

Unit Six. Distribution of Heat.

Problem-Questions :

(a) How is heat transported from place to place?

(b) What are some practical uses and applications of radiation, convection, and conduction?

(c) What are some modern devices for heating the home?

Area VII. THE ATMOSPHERE

Unit One. The Air Around Us.

Problem-Questions :

(a) What are the components of the air?

(b) What are important properties of the air?

(c) What becomes of things when they burn?

Unit Two. Changes in the Content of Air.

Problem-Questions :

(a) How do animals and plants change the content of air?

(b) How does the carbon-dioxide-oxygen cycle affect the content of air?

(c) How does the mitrogen cycle affect the content of air?

Unit Three. Doing Work With Air.

Problem-Questions :

(a) What is air pressure and how is it measured?

(b) How can air pressure be used in doing work?

(c) How does air pressure serve to pump water?

(d) How has man learned to apply the principles of air pressure to move in the air?

Unit Four. Useful Knowledge About the Weather.

Problem-Questions :

(a) What are the causes and the nature of winds and storms?

(b) What is humidity, and why is it important?

(c) What is the relation of humidity to clouds and precipitation?

(d) How do weather reports help man?

Unit Five. Useful Knowledge About Climate.

Problem-Questions :

(a) What are the factors that influence climate?
(b) How is climate related to living things?
(c) Why is the difference of climatic conditions from place to place?

Area VIII. THE EARTH AND THE SKY

Unit One. The Solar System is a Small Part of the Universe.

Problem-Questions :

(a) What does solar System mean?
(b) What are the heavenly bodies in the solar system?
(c) What are comets and meteores?
(d) What are the star constellations?

Unit Two. The Earth.

Problem-Questions :

(a) How did the earth develop?
(b) How and why does the earth's surface change?
(c) What are the causes of night and day?

Unit Three. Keeping Track of Time and Place.

Problem-Questions :

(a) What causes the seasons?
(b) How time and place are determined?

Unit Four. The Moon.

Problem-Questions :

(a) What are the characteristics of the moon?
(b) What are eclipses?

(c) What causes tides?

Area IX. ROCKS AND SOIL

Unit One. Formation of Soil.

Problem-Questions :

(a) How are rocks formed?
(b) How are rocks changed into soil?
(c) How may soil erosion be prevented?
(d) How are soils kept fertile?

Unit Two. The Relation of Soil to Living.

Problem-Questions :

(a) What was the nature of early cultivation?
(b) What are the applications of science to modern agriculture?
(c) How are new varieties of plants produced?

Unit Three. Improvements of Production.

Problem-Questions :

(a) What is the "Golden Fibre"? How is it the biggest national resource?
(b) How are crops improved?
(c) How is the production of vegetables improved?

Unit Four? Protecting Plants and Animals.

Problem-Questions :

(a) What are weeds, and how are they controlled?
(b) How to protect plants from insects?
(c) Why domesticated creatures must be protected?

Unit Five. Use of Animals.

Problem-Questions :

(a) Of what importance are cattle in cultivation?

(b) How important is animal husbandry?

(c) How is livestock improved?

Area X. SURVIVAL OF LIVING THINGS

Unit One. Living Things Reproduce.

Problem-Questions :

(a) How does "life come from life"?

(b) How do animals and plants grow?

(c) How do seed plants reproduce?

Unit Two. Reproduction continues the Species.

Problem-Questions :

(a) How are insects reproduced?

(b) How are mamals reproduced?

(c) How are reptiles reproduced?

Unit Three. Living Things have Changed through the Ages.

Problem-Questions :

(a) What did Mendel discover?

(b) How have plants and animals changed through the ages?

(c) How do plants and animals survive changes in their environment?

(d) In what ways do plants and animals resemble their parents?

Concluding statement. The preceding outline should not be considered as rigid. It is intended that it be considered flexible enough to allow the use of ingenuity on the part of the classroom teacher. Modifications may be deemed desirable in the light of special needs of the local community. In planning a science lesson, it is hoped that the teacher will keep in mind such current events as may be related to his subject. For example, if there is a sudden outbreak of cholera in the locality, he might plan his lesson around this contagious disease, so as to take immediate advantage of the real life stimulus thus provided.

It is hoped that a detailed science program for all pupils of grades six through eight of the high schools of East Pakistan will be developed on the basis of this proposed outline. Such a program will help the development of pupils' basic knowledge in everyday scientific understandings. Later on, in the ninth and the tenth grades when they will study courses in physical and biological sciences, they will be able to grasp more complex scientific phenomena. Thus a well-planned science program for the high school pupils of East Pakistan will lead them to a better understanding of the physical and biological environment, an increased appreciation of scientific achievements, and greater use of science learnings in everyday living for the maximum benefit of the individual, his community and his country.

APPENDIX A

DISTRIBUTION OF PRIMARY SCHOOLS IN EAST PAKISTAN, 1956-57.

Category	Number of schools.
(a) Compulsory schools.	5,122
(b) Non-compulsory schools.	17,634
(c) Schools in Municipal areas. ...	653
(d) Aided schools in District Board areas.	956
(e) Un-aided schools in District Board areas.	1,519
Total	25,884

APPENDIX B

DISTRIBUTION OF SECONDARY SCHOOLS IN EAST PAKISTAN, 1954-55

Category	Number of Institutions		Number of students
High Schools	Government Boys' Schools. ...	30	
	Government Girls' Schools.	7	
	Non-Government Boys' Schools.	1,435	Boys.319,747
	Non-Government Girls' Schools.	63	Girls.23,925
	Total	1,535	Total 343,672
Middle and Junior Schools	Government Boys' Schools. ...	5	
	Government Girls' Schools.	2	
	Non-Government Boys' Schools. ...	1,337	Boys. 90,811
	Non-Government Girls' Schools. ...	200	Girls.22,814
	Junior High Schools for Boys. ...	262	Total 113,625
	Junior High Schools for Girls. ...	8	
	Total	1,814	
Madrasahs	Government Madrasahs	4	Total number of students in the Madrasahs.
	Non-Government Madrasahs	1,826	
	Total	1,830	135,000
Grand Total of Secondary students.			592,297
Percentage of these who are High School students.			77

APPENDIX C

QUESTIONNAIRE SUBMITTED TO SIXTY PAKISTANI STUDENTS (JUDGEMENT ABOUT SCHOOL SUBJECTS)

Please underline the one to which you belong.

You are from East Pakistan/West Pakistan. Sex: Male/Female

The subjects mentioned below are included in the Secondary curriculum of East Pakistan. Two lists, one for boy students and the other for girl students, have been prepared in alphabetical order. You are requested to arrange the subjects according to your own idea of their relative importance (i.e. if you think that "X" is the subject which should be given first preference, put a place-value "1" to its left) Mark the one which is next in importance as "2", and so on.

List for Boy Students

Classical languages (Arabic, Persian, Sanskrit, Latin)
English
Geography
History
Major Vernacular (Bengali or Urdu)
Mathematics
Physical and Health Education
Public Administration
Science

List for Girl Students

Art and Handicraft (Drawing and Painting, Needle Work, Music)
Classical languages (Arabic, Persian, Sanskrit, Pali)
Domestic Science
English
Geography
History
Major Vernacular (Bengali or Urdu)
Mathematics
Physical and Health Education
Public Administration
Science.

APPENDIX D

QUESTIONNAIRE SUBMITTED TO THE PAKISTANI STUDENTS

Please answer the following questions about your schooling upto the tenth grade:

1. In which class of your school education did you begin the study of a course in science?
2. How many years did you study science before you passed your Matriculation Examination or its equivalent?
3. Did you study a course in physics? If so, in which class?
4. Did you study a course in biology? If so, in which class?
5. Did you study a course in chemistry? If so, in which class?
6. Did you study a course in astronomy? If so, in which class?
7. Did you study a course in zoology? If so, in which class?
8. Did you study a course in physiology? If so, in which class?
9. Did you study a course in anatomy? If so, in which class?
10. Did you study a course in botany? If so, in which class?
11. Did you study science courses other than those which have been mentioned here? If so, what course?

APPENDIX D (continued)

12. Did your science teachers have training in science?

13. Did your science teachers have training in teaching methods?

14. Did you have a science laboratory in the high school where you studied?

15. Were you asked to do practical work in the laboratory with your own hands?

16. Give the approximate percentage of time which you think your science teacher/teachers gave to each of the following activities:

Percentage of time:

--------- (a) He delivered lectures

--------- (b) He used materials to demonstrate the lesson to the class.

--------- (c) He conducted field trips.

--------- (d) He asked you to observe, experiment with your own hands and draw inferences.

--------- (e) He used the following additional activities (if any):

_____

Total 100%

Please check the following:-

17. When you read a scientific article in a daily newspaper or a periodical (Check one)

------ You feel disinterested.
------ You feel neutral.
------ You feel interested.
------ You feel very much interested.

18. Do you believe in superstitions? If so, please give two examples:

19. If you do not believe in superstitions in which others believe, do you try to find scientific explanations for

APPENDIX D (Continued)

them or do you ignore them? (Check one).

------- I try to find scientific explanation for them.
------- I ignore them.

20. How do you feel when you are required to handle ordinary mechanical and electrical equipments in your daily life? (Examples - Radios, Telephones, Toilets, Elevators etc.) (Check one).

------- Awkward.
------- Easy.
------- Confident.

21. Do you often ask yourself for a scientific explanation of a phenomenon you observe, or you think that this is primarily the scientists' job? (Check one).

------- I ask for a scientific explanation.
------- I think this is the scientists' job.

APPENDIX E

QUESTIONS FOR TESTING SOME SIXTY PAKISTANI STUDENTS' ACQUAINTANCE WITH SCIENTIFIC KNOWLEDGE

Questions.	Symbols	Percentage of students giving the acceptable answer.
1. What substances are found in air ?	p. m.	55.0
2. How does digestion take place ?	p. m.	33.3
3. How is oxygen supplied to our body cells ?	p. m.	25.0
4. What do you mean by a balanced diet?	p. m.	35.0
5. How does a mercury barometer work ?	p. m.	46.7
6. What temperature is shown by this thermometer(showing a thermometer) ?	p. m.	91.7
7. Why is a day longer or shorter than a night ?	p. m.	28.3
8. Why is it cold in winter and hot in summer ?	p. m.	36.7
9. Give a scientific hypothesis about the origin of the earth.	p. m.	20.0
10. Why is the mid-day sun almost directly overhead in summer and inclined to the south in winter ?	p. m.	33.3
11. How do you find the position of the Pole Star at night ?	p. m.	75.0

APPENDIX E (Continued)

Questions	Symbols	Percentage of students giving the acceptable answer
12. Why do some materials float in water while others sink ?	p. m.	68.3
13. What do you mean by the weight of a body ?	p. m.	76.7
14. What are electrical insulators and conductors ?	p. m.	68.3
15. What makes things burn ?	p. m.	61.7
16. What is meant by the "transformation of energy" ?	p. m.	35.0
17. Explain how a camera lens takes pictures.	p. m.	33.3
18. Why do you see your face in a mirror ?	p. m.	60.0
19. How is a rainbow formed ?	p. m.	13.3
20. Explain what makes it rain.	p. m.	73.3
21. How are thunder and lightning caused ?	p. m.	31.7
22. How does heat make an engine go ?	p. m.	51.7
23. How do electric lamps make light ?	p. m.	61.7
24. Why does some water require more soap in washing clothes than other water ?	p. m.	41.7
25. How are eclipses caused ?	p. m.	26.7
26. What is soil ?	p. m.	68.3

APPENDIX E (Continued)

Questions	Symbols	Percentage of students giving the acceptable answer
27. Name the different parts of a flower.	p. m.	31.7
28. What are the factors responsible for germination of seeds ?	p. m.	75.0
29. Explain why certain piece of land yielded good crops twenty-five years ago, but does not do so now.	p. m.	53.3
30. How do green plants manufacture foods ?	p. m.	38.3

APPENDIX F

ACCEPTABLE ANSWERS TO THE QUESTIONS IN APPENDIX E

(Material included in parentheses was not required in judging an answer as correct)

1. Air is composed of nitrogen (about 78 per cent), oxygen (about 21 per cent), and some rare gases (argon, neon, helium, krypton, and xenon). It also contains small quantities of carbon dioxide and (ozone, some gases which escape from factories, cooking rooms and similar sources,), water vapor, and some solid substances in the form of fine dust.

2. Digestion begins in the mouth. (The teeth break up and crush the solid food.) Saliva acts upon and digests the starch in foods like rice, bread, potato etc., changing into sugar.

   From the mouth the food goes to the stomach where the digestion of proteins and fats is begun (by the gastric juice.) From the stomach the partly digested food passes into the small intestine. Here the digestion of proteins, fats, and starch is completed by a fluid (know as the pancreatic juice). (Bile is added here from the liver. It helps the food to be digested quickly by the digestive fluids).

3. In human respiration, oxygen passes through the walls (of millions) of capillaries in the lungs.

APPENDIX F (Continued)

There it combines with the red corpuscles. The oxygen is first carried by the blood from the lungs to the heart. It is then carried by the blood to all parts of the body.

4. A balanced diet is that which includes adequate food from three main groups of foods - fat, protein, and carbohydrate plus some vitamins, mineral salts and water.

5. The mercury barometer consists of a graduated glass tube of convenient length (about 80 cm.) closed at one end. (It is first filled with mercury and then inverted over a mercury vessel.) The atmospheric pressure acting on the surface of the vessel is transmitted through the mercury into the glass tube. The effect of this pressure is shown in the glass tube by the elevated mercury column the length of which gives the measure of the atmospheric pressure (in terms of the weight of mercury).

6. A clinical Fahrenheit thermometer was given to the individuals. Everyone was asked to give the correct reading of his or her body temperature.

7. The earth while rotating on its axis also tilts on the axis. (It tilts 23.5 degrees from a line drawn from pole to pole through the centre of the earth.) That side tilted toward the sun has longer days and shorter nights than the side tilted away from the sun.

APPENDIX F (Continued)

(If it did not tilt, night and day would be always in length.)

8. Because -

(i) The sun's light and heat strike more directly during summer than during winter.

(ii) There are more hours of daylight in summer than in winter.

The result is that our Northern Hemisphere receives more heat energy from the sun than what it radiates away.

9. The most widely accepted hypothesis about the origin of the solar system, and hence of the earth is as follows:

All the bodies in the solar system were once part of one star which once happened to pass fairly close to another star. The gravitation of each star produced enormous tides on the other. Finally one of these two stars could not stand the strain. It was pulled apart violently and it exploded. The gases composing it were scattered through the space around it. The result was a nebula. In the middle of the nebula there was a big mass of matter composed of most of the original star. Scattered around it, there were other smaller masses of various sizes. These smaller bodies of gas cooled enough to become solid.

The other star that was not pulled apart continued on its way. While it was passing the newly formed nebula, its gravitation pulled the nebula and made started rotating around the central mass. This

APPENDIX F (Continued)

rotation prevented the gravitation of the central body from pulling back into itself the materials composing the nebula. The scattered bodies continued to circle round the central mass. The central mass became the sun. The large bodies, after ages of time, grew into planets.

Third planet from the central mass became the earth.

10. The sun is almost overhead in mid-day summer and inclined to the south in mid-day winter because of the tilt of the earth's axis. In summer the northern hemisphere is tilted toward the sun, while in winter it is away from the sun.

11. There are two stars in the Big Dipper which always point to the Pole star. An imaginary straight line joining these two stars passes through the Pole Star. Its position may also be known with reference to either the Ursa Minor or the Small Bear.

12. When a body is put into water, it displaces water and takes some of its place. The body into water looses a weight equal to the weight of the water which it displaces. If the weight of the displaced water equals the weight of the body itself, the body floats. If the weight of the displaced water is less than that of the body, the body sinks.

13. The weight of a body is the force with which the body and the earth attract each other.

APPENDIX F (Continued)

14. Metals and other substances through which electricity flows readily are called conductors. Substances through which currents scarcely flow are known as insulators.

15. A constant supply of oxygen makes(combustible) things burn. (if the temperature is high enough)

16. The change of one form of energy into another form is known as the "transformation of energy". For example, heat energy may change into light energy, or sound energy into electrical energy or vice versa. Before a gun is fired, the powder in it has chemical energy. While it is exploding, this chemical energy is transformed into several kinds of energy such as heat, light, sound.

17. A photographic camera has certain parts. A pinhole camer, the simplest type consists of a (i) fixed box closed at the front except for a pinhole in the centre. (ii) A ground glass sereen is placed at the back for vewing the image. When the camera is pointed at an object, the glass sereen receives an inverted and reduced image. A double convex lens substituted at the pinhole gives a clearer image. The image is permanently recorded on a light-sensitive film. The film requires a back support (the receptacle) for holding the film. This combination is called a box camera, and represents in action the principles of all cameras.

APPENDIX F (Continued)

18. The mirror is an opaque object with a surface smooth enough to reflect the light in such a way as to show an image. The light is reflected from the mirror to the eye. The eye sees the image of the object which appears to be behind the mirror.

19. A spray of water droplets when illuminated by strong white light from behind, an observer can see one, and sometimes two sets of concentric spectrally colored rings. This is known as the rainbow.

The colors of the rainbow are caused by the reflective dispersion of the spherical water drops. This statement was needed to be explained by means of a simple diagram.

20. Water is evaporated by the heat of the sun from various sources. Whenever air is cooled (to a temperature below its dew point), the condensation of water vapor results. If the condensation takes place above the ground, the water collects on the dust and smoke particles which are present in the air. Thus clouds are formed. If the condensation continues, the drops grow until they become heavy enough to fall to the ground as rain.

21. Lightning is a discharge of electricity, while thunder is due to air expansion and contraction.

Electricity always exists in the atmosphere. Every droplet of moisture has its charge. When drops of water are broken into a spray by a current of air, each little drop becomes charged with positive electricity,

APPENDIX F (Continued)

while the air around each drop gains an equal negative charge.

The positively charged raindrops descend, while the negatively charged air remains near the top. When the electrical attraction due to these mass charges becomes too great, a flash of lightning takes place. As the separated charges reunite in the lightning flash, the air becomes white-hot along a narrow path. This represents the "lightning". The heat causes sudden expansion of the air, and sets up the sound waves which is called "thunder".

22. It is the heat energy which is used to move a machine. (i) Steam can do work. In locomotives the steam is used to push a pison back and forth in a metal cylinder. To do this, steam is made to enter first one end of the cylinder and then to the other. As the piston moves back and forth, it drives the wheels and makes the engine go. (ii) Diesel engines make use of fuel oil. These engines generate electricity which is used to run large motors. These motors make the wheels go around. (iii) The gasoline engine or the automobile engine uses the force of the rapidly burning gasoline vapor to move a piston inside a cylinder. The exploding gasoline exerts great force on the piston which sets the "flywheel" in motion. The broad principle of action of any one of thes three types of machines was accepted as an individual's familiarity with the machine and hence a correct answer to this question.

APPENDIX F (Continued)

23. An electric lamp contains a fine wire made of the metal tungsten, usually in the form of a coil. This wire is called the filament of the lamp. When current passes through the filament, the high resistance of the tungsten wire produces enough heat to cause it to produce a bright light.

24. When water has compounds of calcium and magnesium dissoved in it, it is called hard water. Water without compounds of calcium and magnesium is called soft water.

Soap dissolves and readily forms bubbles, (or surds) in soft water. When soap is put into hard water, it combines with the calcium and magnesium compounds and forms a coating on the surface of the water. No soap bubble is formed until soap has first combined with all the calcium and magnesium compounds in the water. This is the reason why hard water takes more soap than soft water.

25. Illustrations through pictures were required to explain the formation of eclipses with the following verbal explanation:

Sometimes at new moon, the moon is exactly between the sun and the earth, and near enough so that the tip of the moon's cone-shaped shadow passes across the surface of the earth. Because the moon shuts off the sun's rays, the portion of the earth which happens to fall inside the tip of the shadow becomes dark. This is called the total eclipse of the sun. If it falls within partial shadow, a partial eclipse of the sun is caused.

APPENDIX F (Continued)

The lunar eclipse can occur only at full moon. In order to have such an eclipse, the sun, earth, and moon must be in line, the earth being in between the sun and the moon. The earth casts a(long pointed)shadow. When the moon moves into this shadow, its face becomes dark, for no sunlight can fall upon it. There can be either a partial or a total eclipse of the moon.

26. Soil consists of a mixture of rocks and decay plant and animal matter. It is the outermost layer of the earth's crust and is produced chiefly from rocks.

Gray or brown plants, called lichens, grow into scalelike masses. During their growth these plants dissolve a little of the surface of the rock. As a result, when the plant die and fall from the rock, some rock particles fall with them. New lichens grow and old lichens decay. At the same time, air, heat, rain and other agents of weathering are breaking the rock and making soil.

27. The flower may be complete or incomplete. A complete flower has the following four parts:

(i) The outer leaf-like sepals,(which together make up the calyx.)

(ii) The inner(usually brightly colored) petals together make up the corolla.

(iii) The stamens, or anthers(which develop the pollen.)

(iv) The pistil.

APPENDIX F (Continued)

28. The factors responsible for germination of seeds are (i) air, (ii) water and (iii) an adequate temperature.

29. Plants live on carbondioxide from the air and water and dissolved minerals from the soil. Production of a crop every year in the same soil gradually reduces the mineral contents of the soil. If fertilizers or mamires are not supplied to the soil to replace the minerals, other conditions remaining the same, the land will not yield satisfactory result.

30. The green plant manufactures its food in the leaf by a process known as the photosynthesis. The leaves of green plants contain chlorophyll. When sunlight falls upon the plant, the chlorophyll absorbs energy from the sunlight. By means of this energy the carbondioxide from the air and water from the soil are changed into sugar and starches. Some of the simple sugar made by green plants is finally changed into fats (plant oils) and proteins.

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