SUGGESTIONS FOR THE IMPROVEMENT OF SCIENCE EDUCATION IN THE SECONDARY SCHOOLS OF EAST PAKISTAN

By

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SCIENCE EDUCATION

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ABSTRACT

The purpose of this study was to suggest certain changes desirable for the secondary science education of East Pakistan. The methods of this investigation were the qualitative analyses of social conditions, science syllabi, textbooks, examinations and pertinent literature. From an analysis of the social conditions and the nature of the learner a set of criteria for science education was stated and interpreted. In terms of these criteria certain recommendations were formulated and submitted in the form of a questionnaire to fifteen leading science educators of East Pakistan. The recommendations were then revised in the light of their reactions to the questionnaire.

It has been found that most science teachers of the secondary schools are untrained pedagogically. Many schools cannot provide minimum facilities for science education. These schools are gradually lowering their academic standards.

The science syllabi prescribed by the Secondary Education Board show lacks in many areas of science content, e.g. machines, soil analysis and human behavior, which are essential for understanding life in East Pakistan. Also, many units in the prescribed science textbooks provide scanty and superficial scientific information.

The matriculation examinations of the Board encourage but little thinking, and critical reading, criticism, interpretations and applications of science content which are needed in advanced study. The science teachers use mainly lectures and some demonstrations to prepare students for the examinations, rather than emphasizing the science that is related to life affairs.

It has been recommended that the money distributed by the Government as scholarships for all levels of education should be refunded by the scholarship-holders when they are well-placed in life. This amount should be equitably distributed among the secondary schools for increasing laboratory, library and audio-visual materials for science teaching. Suitable reference books, periodicals and films from foreign sources should be translated. And science should be a required subject for the matriculation examination.

Each secondary school should have an experimental guidance program, a science club and a museum. Its headmaster should have such professional education as to help his science teachers in their professional growth, in improving teaching through democratic planning for cooperative teaching units. However, to increase the number of trained teachers, training courses should be offered as an optional subject in suitable degree colleges of East Pakistan. The science teachers' salaries should be adjusted to their qualifications and the teachers should receive pensions after a suitable period of service.

A brief outline of a secondary science curriculum has been recommended. The details of the curriculum should be prepared by a group of specialists in agriculture, industry and health of East Pakistan together with physicists, chemists and biologists, and experienced high school science teachers. Each of the science textbooks should be written by several authors each one contributing the chapters in the areas of his specialization. Suitable science materials should be organized around some major problems of East Pakistan and should be supplemented by appropriate reference books, materials and suggestions for independent investigations at the understanding levels of the students.

Finally, able and interested teachers should be provided facilities to experiment for improving science teaching. Moreover, the Secondary Education Board should issue circulars regarding the use of reference materials and community resources for teaching the units of the existing science textbooks. Moreover, the Board should prepare in the language of instructions the tests of scientific attitudes, aptitudes and achievement standardized for each of the five secondary classes. On the cumulative results of these tests administered, scored and reported by the respective science teachers of the secondary schools, the Board should select candidates for the matriculation examination. The terminal students should be offered certificates based on the yearly examinations of the Board.

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CHAPTER I

INTRODUCTION

Why Teach Science in the Secondary Schools?

Let us assume the following definition of science. Science is a methodical search for discovering causal relationships and underlying facts. Scientific search is based on accurate and unbiased observation, logical analysis and inference. It posits that events are caused. Therefore, human efforts backed by intelligent planning and design of controlled experimentation can unveil causal relations existing among natural forces, harness them to serve mankind by predictions and control of future events, and improve research for further tested facts and generalizations interlinking them.

Science as a method of human intelligence helps man to understand and then to control the forces of his physical environment. Therefore, the control of the recurrent floods and myriad problems of like nature demands scientific knowledge on the part of the youths of East Pakistan. Thus follows one basic reason for strengthening science education of the country.

Science has reduced time and space and consequently made the whole world a large family where Pakistani youths have to discharge their responsibilities. They must play their part in fostering better international understanding. They cannot escape from the universal influence of modern science. Therefore, the schools of East Pakistan should prepare the youths to live in this scientific world by providing appropriate science education.

Let us anticipate some consequences of a non-science secondary school curriculum. According to the Planning Board, the present-day teaching practices in Pakistani schools are focussed on the demands of the next higher schools.[1] For example geography being a subject prescribed in the primary and secondary school curricula is emphasized in the instruction of both the levels of education. But current knowledge being a subject prescribed in the primary school and not in the secondary school curriculum is neglected by students and teachers of the primary schools. Thus if there is science only in the primary school program but not in the secondary school program then science will be ignored even in the primary schools. Since primary school teachers are recruited from the secondary school graduates, the matriculates, they will not have sufficient background knowledge to

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[1] Government of Pakistan: Planning Board, The First Five Year Plan, 1955-60, (Drafts), II, (1956), p. 407.

teach science effectively in the primary schools. Consequently no science will be taught there.

About 50.3% of Pakistani children between the ages of six and eleven were in the primary schools in 1953-54.[2] Statistically, this percentage is applicable to East Pakistan. However, in 1954-55, enrolment in the schools of East Pakistan shows that 6.5% of the entire primary school population were in class V, the final grade. About 52.4% of the 5th grade population were present in class VI, the 1st secondary grade. Only 14.6% of the total secondary school population were in class X, the final grade. And only 20% of the 10th grade population were in college.[3] Since 1954 the foregoing percentages seem to have remained almost constant in the successive years because there had been no great educational change that could have altered the relative order of enrolment in the schools of East Pakistan. Therefore, about $\frac{50.3}{100} \times \frac{6.5}{20} \times \frac{52.4}{100} \times \frac{14.6}{20} \times \frac{20}{100} \times \frac{100}{1} = 1.25\%$ of a given age group usually attend college.

In East Pakistan a matriculate who enters an arts college does not get any opportunity to pursue a science course. Thus he is graduated without any basic

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[2] Ibid., p. 397.

[3] Government of East Pakistan: Chief Minister's Secretariat, Report of the Educational Reforms Commission: East Pakistan, pt. 2, (1957), p.7.

knowledge of science. He, as an educated citizen of the democratic country or as a state officer, has to share responsibilities for making and abiding by the decisions and policies of the country whose present existence and progress are largely dependent on scientific knowledge about health, agriculture and industry. Thus he is unable to discharge his civic responsibilities adequately.

Partly due to literary education and partly due to lack of understanding science vocabulary an arts college graduate does not profit from scientific literature or recent inventions and information about common necessities of daily life. He remains almost ignorant of scientific interpretations of natural phenomena such as lightning, rainfall, will-o-the-wisp, winds, forest-fire, earthquake and so on. When his children show curiosity about natural phenomena he is bound to hush them by fear or to teach them false interpretations and unscientific causation which seem to be the roots of many superstitious beliefs. Thus his children, in preschool days, develop concepts and beliefs which are founded on unscientific evidence and knowledge. They usually believe epidemics and mental disorders to be caused by evil spirits. Symbols of these spirits are sometimes worshipped, and patients are sometimes tortured in order to cure their ailments.

The foregoing applies also to those who enter various spheres of life after primary or after secondary education. Most of them take up an agricultural profession and follow

the stereotyped process of cultivation which is inadequate to meet the demands of the increasing population of the country. They do not learn how to manure their land for yield of better quality and quantity. For the continuously decreasing output of land they have to rationalize almost persistently. Consequently their personality characteristics are affected by poverty due to their ignorance.

Those matriculates who enter science college have to start from scratch, and they consequently attain lower standards at the degree levels. Some of them discover too late that they have no aptitude for and no interest in science; so they drop out. Those who continue up to B.Sc. or M.Sc. levels are very capable of memorizing facts and principles of science. They have to memorize science in order to pass examinations because our society puts a premium on the success in examinations. This emphasis on the token reward of a degree deprives those science graduates of the opportunity for acquiring scientific thought, attitudes and habit patterns. This is done partly because the uncritical or literary thought, attitude and habit pattern acquired up to the last day in the schools resists any change in later life, and partly because college science teachers do not have time to make major changes in their students by consciously planned teaching focused on them. Thus the science graduates become living storehouses of knowledge which scarcely function outside the four walls of the college building. Due to emphasis on memorization

they do not understand science adequately. Disuse and inadequate understanding make them forget science very rapidly. As will be discussed in the section under "Related Study", these consequences prevail in East Pakistan where science is an optional subject for the matriculation examination. Such a situation is detrimental to the national development which is under way.

This situation can be improved by a well-coordinated program of science education in the secondary schools. Emphasis on teaching science in the secondary schools will raise the standard of science education in the primary as well as in the college levels. Students in the secondary level will get opportunities for developing their aptitudes and interests for specific fields of science. With an adequate science program any school-going student will learn basic concepts of science and how to profit from scientific literature both in the schools and in later life.

Pakistan is developing many industrial plants and projects such as of paper, food, medicine, power, atomic fuels, mechanized agriculture and so on. Workers and technicians of these fields are expected to have a basic knowledge of science which undergirds their practices because a practice without knowing its theory is uncoordinated and inefficient. History shows that principles are more durable than their particular applications in

the technology of this rapidly changing civilization. Again, principles once learned help one to learn new skills involving those principles. Therefore, scientific principles and underlying facts, when included in the secondary school program, can be a sound basis for vocational training in related spheres of human occupation. The need for such a science education is evident from the statement:

> The secondary school system must strengthen its teaching of science and applied arts and give pupils more adequate prevocational preparation for careers in agriculture, education, social welfare, business and industry. There is general agreement on this point, but there is uncertainty about methods for accomplishing this desirable objective. [4]

Therefore, it seems that the methods sought in this quotation should be such that whatever is taught in the science classroom will function in the pupils' daily lives and provide new avenues of knowledge in later life. Assuming only limited transfer of learning as shown by modern researches in transfer, these methods should emphasize solving real problems of community life scientifically and cooperatively by pupils under democratic leadership and guidance of the science teacher. How to adapt these methods of teaching to the secondary schools of East Pakistan will be investigated in the present study.

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[4] Government of Pakistan: Planning Board, op.cit. p. 409.

Statement of the Problem

East Pakistan, which is now an independent underdeveloped country, inherited from the British rulers an educational system which is mostly literary and which was meant to produce officials for supporting their administrative machinery. During the past decade since the achievement of her independence in 1947, the country had to face many problems among which educational reform was a felt need of the people. To solve this problem, it may be recalled that the government of East Pakistan appointed a Reform Commission in the year 1957. Although the Commission felt the importance of science education, it had to focus its attention on more general aspects of the entire educational system. This study is intended as a more specific analysis into the science aspect of the broad educational problem of the country.

The present study is concerned with the improvement of science education in the secondary schools of East Pakistan. It is a search for the betterment of science education. Here, the good implies desirable qualities of subsequent experiences that increase the probability of success and progress of the country. Desirable experiences are the means to achieve a generally accepted purpose, an objective. With this idea in mind this study aims at analysing science textbooks, syllabi, examinations, instruction and organization. In this analysis an attempt

has been made to discover strengths and weaknesses and to suggest some realizable modifications in the light of modern concepts of education and learning.

A Related Study

In the academic year 1957-58 a research was conducted at the American University of Beirut by Mohammad Kurshed Ali.[5] The purpose of his study was to show the relative importance of science among other subjects and its role in the high schools of East Pakistan. His method of study was that of library research supplemented by a questionnaire administered to sixty Pakistani students studying at the American University of Beirut. Although

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[5] In order of relative importance of the high school subjects the sixty Pakistani students in Mohammad K. Ali's study estimated science as the third among nine subjects for boys while domestic science the first, and pure science the ninth among eleven subjects for girls. As to the science background of these students there was serious lack of uniformity and continuity in the secondary science program they studied in different schools. About 68% of those who had studied science were taught by trained and qualified science teachers who made effective use of laboratory experiences. However, most of the teaching time was spent in lecturing. As a group these studentshad serious deficiendes in their knowledge of everyday scientific phenomena, although the majority of them were interested in science news and averse to superstitions.

he did not estimate the reliability and validity of the questionnaire and used accidental sampling of subjects coming from the two wings of Pakistan, his findings seem to reflect the general situation of East Pakistan. This is because Pakistan has two almost equal parts called East and West Pakistan, and approximately equal numbers of students from each part were included in his sample. Since the two parts of Pakistan do not differ very widely in educational matters, any findings from such a sample are likely to be largely applicable to the more specific area of East Pakistan.

However, Mohammad K. Ali's findings should be evaluated in the light of the facts that in West Pakistan there are some areas such as Karachi where science is a compulsory subject for the matriculation examination. Most of the Pakistani studying at the American University of Beirut had had better educational opportunities than most. For example they constitute only a small fraction, usually the topmost part of the 1.25% of an age-group that enters college. In view of all these facts and findings it seems that the general condition of science education in the secondary schools of East Pakistan must be regarded as being in even more deplorable condition than what the study of Muhammad K. Ali would lead one to suppose.

In the year 1956 the Bureau of Secondary Curriculum Development, New York State Department of Education, prepared a science program for grades seven through nine. The outline of this program has been recommended by Mohammad Khurshed Ali for grades six through eight of the secondary schools of East Pakistan. Such a science program does not seem feasible in East Pakistan because it is an underdeveloped country while New York state is very well-developed, and because any system of effective education should grow in and be adapted to the needs of the country. For example, to realize the proposed science program in grades six through eight a background preparation equivalent to that of the sixth grade science in New York state is essential, but such an advanced preparation cannot be expected from a primary schooling during the period of five years in East Pakistan. Moreover, his study did not present ways and means for adapting that science program in the first three years of the secondary schools of East Pakistan. The present investigation hopes to explore this and other features of secondary science instruction more fully.

Methods of Study

Methods of the present investigation consisted of critical analyses of science text-books, syllabi, examinations, records of success and failure in the examination, and review of literature on science education in Pakistan

and abroad. Recommendations that emerged from the analyses were framed in a questionnaire. The questionnaire was then sent to a group of fifteen East Pakistani educators having science backgrounds. The group was composed of science teachers of secondary schools, colleges and universities, specialists in health, agriculture and industry, and a representative of the Education Reform commission. The specialists selected for this study were once science teachers of college or an University. The purpose of the questionnaire was to get their reactions and suggestions on the proposed recommendations. Having secured their views and suggestions, the final recommendations have been framed in such a way as to give them a maximum chance of being realizable in East Pakistan.

In the questionnaire, twenty-two recommendations were briefly stated in simple English. The questionnaire was then submitted to two experts at the American University of Beirut for their suggestions and criticisms. After revision in the light of their suggestions the recommendations as stated in the questionnaire were given to four Pakistani students for reading. The purpose, here, was to find whether the statements of the recommendation really meant the same thing to these Pakistanis, and whether that meaning was exactly what the writer intended. This was done by asking, "Please tell me in your own language what each of these recommendations means to you." If any statement was found to convey a meaning other than what was intended, the statement was modified in the light

of their suggestions so as to convey the intended meaning to the four Pakistani students. This whole process of revision was undertaken in order to make the questionnaire as objective and valid as possible within the limits of this study. The revised questionnaire has been presented in Appendix A.

Delimitations

The present study is concerned with the amendment of certain aspects of science textbooks, syllabi, examinations, teaching methods and organization of the secondary schools of East Pakistan. Although it is desirable to investigate the entire program of secondary education, the study had to be restricted to science education because of the limited time and other facilities available, and because of the writer's special interest in science. Again, science education at the primary school and college level has been excluded from this investigation in order to keep this study within reasonable bounds.

Keeping in mind these limits of the study, criteria in terms of which suggestions will be made have been discussed in the next chapter.

CHAPTER II

CRITERIA FOR SUGGESTIONS

In this chapter existing social conditions of East Pakistan are analysed in order to discover some social needs pertinent to science education. Then the nature of the learner is discussed in the light of modern psychology. In view of all these, appropriate objectives of science education have been formulated and interpreted.

Transition from Autocracy to Democracy

During the British rule from 1757 to 1947 the people of East Pakistan had to conform to the authority of the foreign rulers who used to decide their fate and the policies for the country. The majority of the people had nothing but to obey the ruling class. Thus good was synonymous with conformity and obedience to the foreign authority. After the independence of 1947, the Pakistanis have achieved the right of self-government, and may make decisions and policies for themselves.

The people of Pakistan have adopted a constitution granting freedom of speech, freedom of association, freedom of movement, freedom of profession and business within the security of Pakistan, and equality before law.[1]

When everybody in a social group wants to speak at one time, no one gets the proper chance for effective speech. Another restriction is that freedom must be exercised within the security of the state. All these imply that freedom of speech goes along with sound judgment, reasoning, self-responsibility and improved communication skills. Equality before law implies dignity of an individual irrespective of his religion, caste, race or social status. According to the constitution religious instruction and participation are optional in the schools of Pakistan.[2] Thus an individual is safeguarded against discrimination due to religion so that better cooperation among all individuals in a school is achieved. In fact, cooperation among different groups and among individuals in a group is essential for the security and the stability of the new-born state.

From the foregoing it is evident that the secondary schools must teach the values of social democracy.

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[1] Ministry of Law, The Constitution of the Islamic Republic of Pakistan, (1956), pp. 8-10.

[2] Ibid., p. 11.

Unfortunately, the road to the realization of this educational objective is barred by several obstacles which must be surmounted by the proper education of the oncoming generation. These are an autocratic human environment, mass illiteracy, inappropriate school education, cultural conditioning, undesirable ethnic attitudes and internal migration. These obstacles are considered in detail in the sections immediately following.

Autocratic Human Environment. In a typical East Pakistani family a child is expected to obey all the commands of his parents and his elders. Such an obedience is taught to the freedom-loving child by using fear, threats and punishments, but rarely any reasoning. When he goes to the school he is told by his parents to obey and do whatever is said by the teacher. Consequently, when the teacher, after pointing his finger to a line on the reader, says, "Read. A horse is running." The child reads, "Read. A horse is running." At this ridiculous matter the teacher may scold, "You are a fool." The child repeats, "You are a fool." Such funny incidents are very frequent in the primary schools because most parents warn the school-going child against doing and saying anything other than what his teacher wishes and says. Thus he is brought up in a social climate where any adult is looked upon by him as an authority to be obeyed without reasoning and questioning. His initiative, originality, self-direction and self-responsibility are nipped in the bud.

Under such circumstances a child tends to develop a neurotic personality and become very suggestible. Carefully controlled experiments of Pavlov and Masserman have shown that approach-avoidance conflict produces neurosis in the organism.[3] For example, the child approaches his parents for satisfaction of his primary needs, such as food, shelter and so on. When they punish him, he tries to avoid them because he learns to fear their presence. Due to his childhood dependency he cannot go away from them. Thus he faces an approach-avoidance conflict. Therefore, punishment by parents may produce neurotic symptoms, namely, deranged thinking, feelings of guilt, destructive fantasies, and asocial behavior in the child. In consequence, the parents and the teacher are likely to consider him a "bad child". So, they use more punishment in order to straighten him out. Consequently, his behavior becomes worse and they feel that their assumption is confirmed. Thus is a vicious circle often set up in the human environment of the child in East Pakistan. He develops negative attitudes toward parents and teachers, toward anything related to and resembling them. Since attitude affects perception directly, the child perceives only those elements of his experiences with them that

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[3] For details, see Laurance Frederic Shaffer and Edward Joseph Shoben, The Psychology of Adjustment, 2nd ed., (1956), pp. 112-16.

support his negative attitudes which, therefore persist and grow. These may account partially for the 61.3% dropout rate[4] within the first one year of primary school.

Mass Illiteracy. According to the 1951 Census, 84% of the population of East Pakistan are illiterate.[5] The literate group, 16% of the population, includes those who can somehow write and read any language. Due to lack of communication skills and consequently retarded mental abilities, the illiterate people cannot decide their fate. Most of them do not understand what to do for the betterment of themselves and of their country. They remain totally dependent upon the minority group of literate people in matters of decisions and policies. Thus the ignorant people are, as it were, the slaves of a civilized nation.

Inappropriate School Education. The so-called educated people usually try to exploit the rights of the other people and are mostly authoritarian because they have been trained in authoritarian homes and schools. The present-day schools of East Pakistan encourage extreme competition among students in order to motivate learning of the factual information in the prescribed textbook. Consequently, the academically gifted students learn how to defeat their classmates. Thus they develop an attitude

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[4]Chief Minister's Secretariat, Report of the Edl. Reform Commission: E. Pakistan, pt. 2, (1957), p.7.

[5]Ibid., p. 1.

of superiority which tends to function in social situations. But the academic training does not help them to solve challenging problems of social life. As a result, to display their pseudo-superiority, they sometimes take recourse to exploiting the rights of their neighbors. For example, educated and well-connected persons are often found to collect their ration goods without waiting for their turn in the queue in front of the rationshop. Many similar instances of special privilege are frequent among them. Today's secondary schools do not produce the type of boys who have the qualities of character, personality and self-discipline which are needed in public service.[6] The educated persons are often found to quarrel and fight in playgrounds and in other social gatherings. Thus the interpersonal relations are not always pleasant and friendly among them. That is why they cannot work together for their common good. An example is the failure of many political parties in Pakistan.

Another outcome of the present secondary schools is the development of uncritical attitudes on the parts of the students. They have to accept the unquestionable authority of the prescribed text-materials and lectures on them given by the teachers. Through stimulus generalization,[7] they tend to accept printed advertisements

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[6] Government of Pakistan: Education Division, Proceedings of the Educational Conference Held at Karachi on the 4th and 5th December, 1951, (1951), p. 373.

[7] Stimulus generalization is a process of transferring a response from one stimulus to another similar stimulus.

(supplemented by the contrived lectures of the salesmen) as truth beyond doubt. Consequently, they frequently buy adulterated foodstuffs and pseudo-medicines for their own use.

Cultural Conditioning. Another factor probably contributing to the uncritical nature of the educated people is the literary culture of East Pakistan where homes, schools and libraries are filled with popular literature. Most of this literature is full of fantasies which once ameliorated the tension of the people frustrated under foreign domination. Those fantasies demand beliefs without reasoning in order to enjoy their ameliorative effects. As an example, Nazrul Islam, today's greatest poet of East Pakistan has written:

> My songs like a wounded bird fall fluttering at your feet,
> O my darling;
> Lift my songbird, pierced by arrows, gently to thy breast,
> O my darling.
> He will meet his death at your feet beautiful, unparalleled!
> How lightly he was soaring in the Heaven on wings of tune!
> But alas! how unobserved you pierced him with shafts from your eyes.[8]

Exclusive preoccupation with such popular literature notably makes the educated people less realistic and less critical. Moreover, the educational institutions are very poor in the collection of scientific literature because

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[8] Translated by Qazi Mutahar Husain, the Cultural Heritage of Pakistan, ed. S.M. Iram and Percival, Spear (1955), pp. 142-43.

most of it has to be imported from foreign countries, and Pakistan earns very limited foreign exchange, which is mainly spent for importing food and developmental equipment.

The present society regards critical habits to be undesirable--at least any criticisms of the status quo on the part of children are met with firm resistance by adults. This social value may be due to the dogmatic teachings of the religious preachers known as Maulana and Maulavis. They teach people that their interpretation of the message of the prophet, Muhammad, is infallible. Therefore, everybody must accept their interpretation without any doubt and criticism. For example, Mohammad Ali Jinnah, the father of Pakistan said in his message to the Punjal Muslim Students' Federation in 1942, "We have in no small degree removed the unwholesome influence and fear of a certain section that used to pass off as Maulana and Maulvis."[9]

Ethnic Attitudes. Up till 1956 about 1.4 million Muslims from India migrated to East Pakistan.[10] These refugees with varying ethnic origins, diverse needs and background have to be integrated into the society of East Pakistan for its stability and security. Therefore, provincial attitudes must be submitted by cooperation between non-refugees and refugees.

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[9] Ibid., p. 204.

[10] Planning Board, The First Five Year Plan, II, (1956), p. 516.

About 22% of the population of East Pakistan are Hindu.[11] Any slight quarrel or rumor of riot among Hindus and Muslims in East Pakistan is usually followed by threatening and sometimes massacre of Muslims in India. This results in the increase of tension between the two neighboring states and migration of Hindus from East Pakistan and Muslims from India. Thus internal problems of rehabilitating refugees, as well as ethnic and religious prejudices flare up occasionally.

Internal Migration. It may be recalled that the present system of education does not help secondary school graduates in adjustment to social problems. Comsequently, most of them migrate from their village societies to nearby towns where social pressures are more relaxed. Another factor that attracts them is the prospect of jobs and better income which are available though very limited in today's towns and cities. This migration of the educated people from villages to towns creates problems of economy, health and safety. For example, villagers being unaccustomed to the modern equipment of urban life face more accidents than urban persons. Problems of economy and health have been presented in the next sections.

Traditionally parents expect their sons to live

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[11] Chief Minister's Secretariat, op. cit., p. 1.

with them throughout their life-time and to support them in their old age. When the educated sons leave their parents in their homestead and take up urban life with very limited income, most of them have to live from hand to mouth and dwell in crowded houses. Thus they can neither live with their parents nor help them financially. Consequently, parents are frustrated by the behavior of their educated sons for the cost of whose education the entire family had to suffer hardships. As a result of frustrations, some parents develop negative attitudes toward secondary and higher education. This is one basic reason for the low (only 1.25% of an age group) enrolment in colleges.

Problems of Economic Efficiency

Obviously the educational progress of a country depends largely upon her economic progress, which, in turn, depends upon the qualities of education received by the countrymen. For example, an economically advanced country can afford enough money, energy and time to improve her education. Again, an improved education provides people with better attitudes, skills and habits for developing available resources of the country leading to further economic progress. Thus an improved science education in East Pakistan should direct teaching toward the problems of economic development of the country which are taken up in the sections immediately following.

From October,1953 to August, 1954, a team of trained investigators[12] made a systematic study of the economic and health conditions of the people of East Pakistan. Methods used in this study were questionnaire, interview, observation and statistical survey. The reliability and validity of the results were checked by comparing results obtained by one method with that by another. The subsequent discussion is mainly based upon the data abstracted from the report of that study.

Agriculture. East Pakistan covers an area of approximately 54,141 square miles excluding 9,800 square miles of large rivers which are navigable and rich in fishes. The greater part of the country is level ground. Of the total area 9.1% is covered by forest of Sunderban and Chittagong, and 60% is cultivated. Of the cultivated area 82% grows rice and 7% jute.[13] Other important resources are forestry, cattle, sheep, goats, poultry and fisheries.

Per capita income is very low in East Pakistan and was estimated at $ 43.2 in 1948-49. Of 41.93 million total population 31.03% are earners, and the rest are children and other dependents. The proportion of earners to dependents is higher in urban areas than in rural areas where

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[12] A.F.A. Husain, Social and Human Impact of Technological Change in Pakistan: A Report on a Survey... Dacca University... UNESCO, I, (1956).

[13] In spite of climatic and natural advantages the yield of rice per acre is only about half of that in China and one-third of that in Japan. The probable causes of the low yields are failure to use better seeds, manures, irrigation in dry seasons and rotation of crops.

96% of the population live. Of the total earners 82.3% are cultivators who work on land. For every 1000 males there are 88.46 female earners who in agricultural families do house work, drying, boiling and husking unmilled rice, feeding cattle, etc.[14]

Thus the major part of the national income comes from agriculture which is of an obsolete type. The cultivators are mostly ignorant of the recent progress in agricultural science in other parts of the world. They also do not know how to preserve their crops from diseases. During the harvest, the tradesmen take advantage of the farmers' ignorance by buying the harvested crops at very low rates. Thus the few tradespeople take the lion's share of the national income. However, the ignorant cultivators cannot cooperate effectively with the agricultural experts for improving their methods of cultivation and preservation of crops. They tend to resist any developmental change from the status quo. Thus follows the need for the growth of new attitudes and behaviors in the new generation of East Pakistan.

Industrialization. After 1947 many Hindus holding ownership of various industrial plants, such as cotton textile mills, jute baling presses, general engineering, etc. migrated with their belongings to India. Since then some trading Muslims of India have been migrating to East Pakistan. They have been cooperating with the people and

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[14] A.F.A. Husain, op. cit., pp. 41-46.

the government of East Pakistan in developing her essential industries so as to make her a self-dependent country. Thus industrial changes have been rapid, especially in the industries of hides, wood, paper printing, glass, chemicals, food, drinks, tobacco, engineering, jute and cotton. In the years between 1947 and 1953, the number of factories in those areas have increased from 311 to 456 and the number of workers from 46,451 to 75,979.[15]

From the preceding numerical data it is seen that the number of industrial plants has increased by 46.6% while the number of workers has increased by 63.6%. Thus the industries have expanded in number as well as in size. This trend of industrial expansion demands that science education should orient appropriate students to become skillful workers, technicians and researchers who can fill the vacuum being created for their talents and thus make wise use of the available resources of East Pakistan. It is interesting from an educational point of view that according to the one-year survey the factory workers have a definitely higher standard of literacy and a more positive attitude toward education than the general run of the population.[16]

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[15] Ibid., pp. 104-109.

[16] Ibid., p. 204.

Problems of Health

Many industrial plants using modern machinery and equipment attract young people to work with them. Most of these industries are located in areas where means of transportation and communication are naturally available, namely, towns and riversides. Such areas being very limited, the population is very dense there. Disposal of wastes from the factories, insufficient ventilation and excessive heat create many problems of health for the workers and decrease their efficiency. Many workers, being unable to adjust to their fellow men coming from various places, sometimes take recourse to drinking, gambling and sex-indulgence. They do not know how to entertain themselves by creating healthful recreations in a healthful environment. They also do not know how to control carriers of various diseases prevalent in the country. Consequently, when a contagious disease like influenza, typhoid, smallpox or cholera breaks out in one family, the entire community is quickly infected. This conclusion is also applicable to the entire population.

> Potable water supply is available to only 6% of the population and even this is generally inadequate in both quantity and quality. Arrangements for disposal of sewage are even less satisfactory, with underground drainage arrangements available to only about 2% of the population. As a result, bowel diseases are widespread. Malaria takes a heavy toll of life and health; it incapacitates millions, often at seasons of the year when agricultural work is at its peak. The percentage of deaths among mothers and infants in this country is still among the highest in the world. 17

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[17] Planning Board, The First Five Year Plan, II, (1956), pp. 482-83.

Moreover, a very high birth rate is compensated for by a very high death rate in East Pakistan.[18] According to one investigator, protein deficiency in the food produces higher fertility of reproductive cells and more susceptibility to diseases, thus resulting in high birth and death rates.[19] This conclusion has been confirmed by experiments with animals. Thus, the very high birth and death rates among the East Pakistanis are probably due to protein deficiency in their food. Thus it seems that most people of East Pakistan are either ignorant of or careless about the need for a balanced diet. Their carelessness or ignorance leads to misuse or waste of natural resources. As an example, in the summer season abundant fish are available but scarcely anybody preserves them for use throughout the whole year. Consequently, rotten fish are wasted and the resulting unsanitary environment breeds flies and feeds rats which in turn, act as vectors for the spread of certain diseases.

The Nature of the Learner

A child is a growing organism. Growth takes place through constant interaction of the whole child with his environment. It is a continuous process of differentiation

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[18] A.F.A. Husain, op. cit., p. 44.

[19] Josue De Castro, The Geography of Hunger, (1952), pp. 71-72.

and integration. For example in physical growth, differentiation means multiplication of body cells by division, and integration implies coordination of these cells into tissues and of these tissues into organs. In mental growth differentiation implies perceiving similarities and dissimilarities in a series of sense experiences, integration means organizing the similarities into a generalization. The rate of growth depends upon inherited potentialities and environmental stimulation—nutrition in the case of physical growth and opportunities for learning in the case of mental growth. These two types of stimulation may be different for the same child. Thus the rate of growth in a given trait, say weight of a child, may be different from that of his reasoning. Again, the rate of growth in reasoning of a child A, is different from that in another child B because B's inherited potentialities are different from that of A(provided they are not identical twins) and because B's environmental stimulation is different from that of A. These differences in the rate of growth produce individual differences in various traits of an individual and among individuals.

Readiness. In learning a given act, say reading, a child requires certain maturation, namely, the coordination of eye muscles and experiences with alphabets. Unless he is ready to read in terms of his maturation and experiences, teaching does not produce effective results; on the other hand he may learn to fear or to hate reading,

school and teacher. Conversely, teaching him something, for which he is ready to learn, produces effective results and makes him like teaching-learning. This phenomenon of readiness for learning can be illustrated as follows.

In a study of readiness for reading Willard C. Olson found that 2% of the first graders were ready for the Nursery school book level, 23% were ready for the kindergarten book, 50% were ready for the first-grade book, 23% were ready for the second-grade book and 2% for the third-grade book. He also found that 7% of the sixth graders were not ready for books above the second-grade level.[20]

Motivation. According to many psychologists, motivation is essential for learning.[21] Experiments of Ebbinghans and Krueger show that "Other things being equal, retention increases as the degree of original learning increases."[22] The degree of original learning is an indirect and approximate measure of the strength of the motive behind the learning. Therefore, other things being equal, retention of learning is directly proportional to the strength of the motive behind it. Thus it seems very important to discuss the genesis of human motives.

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[20] Glenn Meyers Blair et al., Educational Psychology, (1954), p. 115.

[21] Normal L. Munn, Psychology, 3rd ed., (1956), pp. 253-54.

[22] John A. McGeoch, The Psychology of Human Learning: An Introduction, (1942), p. 377.

At birth the child is a bundle of potentialities and needs. Among these needs are the needs for food, air, and warmth. These needs produce physiological changes within the child who then feels a tension known as a drive. Now, by trial and error or by conditioned reflex[23] he learns specific behavior by which he attains a goal and thereby satisfies his need or reduces his tension. By this process his goal-directed behavior is reinforced. Thus he learns a motive consisting of a need, a goal-directed activity and a goal. A goal is usually known as a purpose of the learner. In the course of time when the need and the corresponding goal lose their significance to the learner, the reinforced behavior tends to be repeated as a habit. Thus in course of time, most of the underlying purposes of his behavior pattern become unknown to him. In this way his biological urges are modified into habits and motives which are the dynamics of his behavior pattern. Moreover, many of his motives are social, namely freedom, recognition, security, love and so on, because goal objects are usually provided by his human environment beginning from the parents.

Learning by Problem Solving. When the learner's habit or motive is

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[23]Conditioned reflex is the process of transferring involuntary response from a stimulus to another stimulus occuring together with the previous one.

thwarted he feels a problem-situation where his reinforced behavior fails to achieve the goal. Now, he observes the problem-situation, then tries to perceive relationships between his past experiences and the confronted problem. He is developing insight into the total problem-situation in the light of his previous experiences. If he descovers any relationship pertinent to the problem, he may solve it and reach the goal. Thus he acquires new meanings from his interaction with his environment and changes his behavior accordingly. An example is the change in meaning of a walking-stick when it has been used by the learner in getting a ripe mango from a tree. This type of learning is longest retained because thwarting, within the limit of the learner's maturation, increases the strength of his motive to the maximum. However, it is evident from the example cited that the meaning of a thing is associated with its use. In fact, the learning becomes more and more meaningful as it is used in novel situations.

If the learner is confronted with a problem unrelated to his past experiences, he observes its various aspects, organizes his observations and anticipates various possible ways of solving it. Finally, he selects the solution that can stand the test of his reasoning and experiences. Thus learning by problem-solving is a creative act. However, in every act of learning by problem-solving, he organizes the meaning (interpretation

of sensory experiences) of relevant things of his environment to make generalizations called concepts. He acquires the skill of learning, that is, the ability to attack and solve the problem. For example, one day a student while returning from a market fell on the street and common salt from his bag was spread on the road. He was faced with a problem of getting the salt out of sand of the road, but he did not know the process of separating the components of a chemical mixture. Luckily, a passing science teacher suggested him the procedures of separating the salt from the sand. Thus he learned to isolate sand from common salt and felt the study of science to be very important. A learner's feeling may be favorable or unfavorable toward a given thing depending upon the learning situation. His favorable feeling that is supported by his reasoning may be called his appreciation. An organization of his motive for, feeling toward and concept of a given thing may be termed as his mind-set or attitude toward that thing.

The learner's motives and attitude affects his perception, meaning of the thing related to them. For example, a child, who has had traumatic experience with his father, may avoid and dislike his father. Any lesson related to his father may become very difficult for him to remember. Now, if his father buys for him a toy which he likes very much, he may learn to like his father and may not find any more difficulty in remembering the said lesson.

Thus any learning experience may change the motive, attitude and concept to which the experience is related. Individual differences in learning capacities and opportunities to learn produce individual difference in motives, attitudes and concepts of the learner.

Objectives of Science Education

Effective science instruction requires a clear understanding of its objectives, their relation to the particular classroom experiences selected and to the broad aims of general education. In fact, objectives are the criteria in terms of which classroom experiences are usually selected by intelligent planning. When these objectives are clearly understood, accepted and appreciated by students, they motivate learning activities. Thus the accepted objectives determine the direction of educational growth of the students. A good evaluation of the teaching-learning process is always made in terms of the accepted objectives.

The following classification of objectives is intended for theoretical discussion; in practice, many of them are intertwined in any classroom situation. However, the statement of the objectives has emerged from an analysis of the relation of science to democratic society, the social conditions of East Pakistan, the nature

of the learner and functions of secondary education in the social order of East Pakistan. Regarding the functions of the secondary schools the following statement deserves due consideration.

> These 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 also feel that they have some definite obligations in these respects. 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. Ideals and standards of co-operative living and of achievement will be imparted to them through their school activities. 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. [24]

Functional Knowledge. Scientific experiences should be so selected that relationships between whatever is taught in the science classroom and the areas of human experience become clear to the students. Also, they should be provided available opportunities to use science in those areas. As an example, the teaching of energy transformation and conservation can be made functional by undertaking a field trip to local manufacturing centers, followed by related project activities of social value. Some universal objectives of functional science teaching in a democratic society are:

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[24] Chief Minister's Secretariat, Report of the Edl. Reforms Commission: East Pakistan, pt. 1, (1957), p. 18.

A. Functional information or facts about such matters as:

1. Our universe--earth, sun, moon, stars, weather and climate.
2. Living things--plants and animals.
3. The human body--structure, functions and care.
4. The nature of matter--elements, compounds, mixtures, chemical change, physical change, solids, liquids, gases.
5. Energy--sources, types of energy, machines.
6. Contributions of science to the life of our times--radio, telephone, telegraph, electric lights, motion picture, household appliances and airplanes.

B. Functional concepts, such as:

1. Space is vast.
2. The earth is very old.
3. All life has evolved from simpler forms.
4. All matter is probably electrical in structure.

C. Functional understanding of principles, such as:

1. All living things reproduce their kind.
2. Changes in the seasons and differences in weather and climate depend largely upon the relation of the earth to the sun.
3. Energy can be changed from one form to another.
4. All matter is composed of single elements or combinations of elements.
5. Living things in a given environment or locality are mutually interdependent. 25

Scientific Methods. An individual who has developed scientific abilities can independently and cooperatively solve the science-related problems of life by using systematic, unbiased and accurate observations, experimentation with adequate controls, logical analysis of observed data leading to a tentative conclusion, verifying the conclusion and using it as a premise for further conclusion and inference. For example, "How may I go about choosing what temperature is most suitable for preserving our potatoes from pathological bacteria? How shall I get instruction

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25 The National Society for the Study of Education, The Forty Sixth Yearbook, pt. 1, (1947), pp.28-29.

on how to remove the yellow spot from my shirt without destroying the cloth?" Questions like these are the starting points from which to develop attitudes of problem-solving through experiences in scientific methods.

Scientific Attitudes. In the course of using scientific methods of problem-solving the learner develops certain beliefs such as: events are caused; scientific generalizations are not absolute but relative to available facts and levels of human understanding; new facts are coming in; values and principles based on facts are, therefore, changing; consequently, truth-seeking minds should be kept open to new facts, principles and values, and evaluate them critically. Thus follows the need to develop critical abilities. According to one professor of science education, critical abilities consist of the following competencies.

> 1. The ability to locate and define problems in the matrix of confused patterns in which they are commonly found in real-life situations.
> 2. The ability to outline problems so that they may be analyzed and attacked by a logical sequence of steps.
> 3. The ability to secure relevant information from appropriate references and to distinguish between data that are valid and those that are invalid. This includes recognition of the basis of authority in any field and the meaning of authority in science.
> 4. An increasingly explicit understanding of science as a method of formal inquiry, with recognition of both its potential usefulness and its limitations when applied to socio-economic affairs.
> 5. Recognition of the validity of group as well as individual attack on problems and recognition of the common requirements of freedom for the advance of both democracy and science.

> 6. Increased ability in the communication arts--reading with perception and understanding, critical listening, effective speaking and writing, and effective participation in group discussion.
> 7. A tendency to act in accordance with available facts and within the value systems of both democracy and science. 26

Interests and Appreciations. Interest provides intrinsic motivation and thereby makes one a serious and efficient learner. A student, who has grown persistent interest in science, is apt to study science after his last graduation.

> He should actually be curious about the scientific problems with which he is faced and be concerned in their solution. He should be moved by the drama of scientific progress. He should feel humble and at the same time be proud of the achievement of men of science as they have conquered ignorance, and he should be confident that man through science can achieve his lasting welfare... Such emotional experiences are entirely practicable as parts of science learning. They are more than practicable; they are essential, if attitudes, interests and appreciations of functional power are to be developed at all. 27

When something satisfies one's purpose and he can comprehend that thing, he is likely to be interested in it and may feel it important to learn. If his feeling of importance is also supported by his reasoning, he begins to appreciate it. When he is interested in and appreciates a given branch of science he may learn it as vocational or recreational activity. Thus it seems

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[26] R. Will Burnett, Teaching Science in the Secondary School, (1957), pp. 34-35.

[27] The National Society for the Study of Education, op. cit., p. 34.

desirable that classroom planning should make the possible relationships between students' purposes and learning experiences clear to them.

College Preparation. An analysis of studies on college preparation seems to show that success in college depends more on increased power of analysis, critical reading and thinking, independent and reflective thinking than the mere acquisition of a fund of scientific facts.[28] Of course, a knowledge of scientific facts and generalizations is essential for scientific analysis and reflective thinking. Thus it seems that a good college preparation may be achieved by selecting the methods and materials of science instruction in terms of the objectives described above. Indeed, these objectives comprise of the development of such skills, habits, concepts, abilities and attitudes as are necessary for furthering science studies in all spheres of life. Thus "Functional knowledge" is expected to function in college science classes.

Citizenship. In the science classroom citizenship should be learned by encouraging each student to live like a democratic citizen. Classroom activities should be conducted in a democratic procedure under the leadership of the science teacher. In order to integrate

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[28] R. Will Burnett, op. cit., p. 99.

the science program with thetotal program of the school, the science teacher should cooperate with social science teachers in such a way that the principles of democratic citizenship taught by them are transferred to the science classroom. The science teacher should respect every student, and grant him freedom and self-responsibility according to his abilities in cooperative group activities in order to develop initiative,self-direction and self-confidence in him. He should also teach the possibility of using science in discharging civic responsibilities. As an example, what should the informed citizens do in fighting epidemics, in having pure drinking water or an atomic power plant in the country?

Personality Development. In East Pakistan, the development of an individual's personality is the general aim of secondary education. The science teacher of a secondary school is expected to cooperate with other teachers in all-round development of the students' personalities. Personality of an individual determines his worth and develops through adjustment to his social environment. Adjustment implies balanced satisfaction of an individual's motives through socially acceptable activities. For example, the motive to gain recognition may be satisfied by securing high marks in the examinations, through cheating or by keeping the record of class

attendance. Cheating is socially unaccepted and helps one develop an undesirable personality. The other two activities being acceptable help one develop a desirable personality.

Thus the science teacher should provide available opportunities for group activities in order to satisfy students' needs for security, belongingness, love, independence and so on. He should help every student to obtain reasonable satisfaction from group participation and thus to be imbued with the rules, values and ideals of the social group. Furthermore, the science teacher should attempt to adjust the level of his instruction to the levels of students' comprehension so that no one feels inferior or superior. He should set up realistic goal for each individual to achieve. However, the science teacher should have a well-adjusted personality because an integrative personality tends to induce integrative behavior among others.

Economic Efficiency. An individual who has developed economic efficiency understands and practices wise production, conservation and consumption of the natural resources available to him. Furthermore, the science teacher should offer more mathematical and physical sciences to those having aptitudes for and interest in engineering careers, and more biological and chemical sciences to those oriented toward medical careers. Those who cannot pursue college education should be offered more

immediately applicable science instruction (e.g., agricultural sciences, in village areas, and industrial sciences as determined by the industries of the locality). How to achieve this in practice is discussed in the section of "Guidance in chapter 3.

Health. A student should be helped to understand and apply the knowledge of the anatomy and normal functions of the human body, balanced diet, sanitation, control of the carriers of diseases, safety rules and habits. Besides, socially acceptable human sex behavior is learned and is not instinctive. If the adolescents are not provided dependable information in the secondary school, they are likely to learn fear and misinformation about sex and reproduction from ignorant people. This may be detrimental to their mental and physical health and should be checked by a suitable program of sex education. Further discussion on this issue is presented in the sections on syllabi and textbooks of chapter 4.

Analyses and recommendations of the subsequent chapters are based on the criteria described throughout this chapter.

CHAPTER III

A CRITICAL SURVEY OF SECONDARY SCIENCE EDUCATION IN EAST PAKISTAN

In this chapter an attempt has been made to analyze the existing opportunities for science education and their coordination for the attainment of its objectives. In the light of the criteria described in the previous chapter some practicable suggestions have been put forward. Implementation of these proposals may result in the growth of the students toward the objectives of science education.

Inequalities of Opportunities

Under the existing conditions of East Pakistan, opportunities for science education are not equitably distributed among the people. Such inequality may be traced to the inequality of geographical scatter of the secondary schools and the inequality of the educational opportunities available in them. These two factors discussed in the sections immediately following.

Geographical Inequalities. The secondary schools are of four types. One type known as junior high school has classes six through ten. Another type of high school has sixth through tenth classes. All junior high schools have a primary stage of grades one through five but a high school may not have any primary stage attached with it. A third type of secondary school known as a Madrasah has also junior and senior stages like the other secondary schools. In Madrasahs religion is emphasized at the cost of instruction in the English language. Almost the same science syllabus is followed in all types of the secondary schools. According to the Report of Educational Reforms East Pakistan has 1535 high schools, 1814 junior high schools, 380 senior Madrasahs and 1450 junior Madrasahs. Of all these, there are only 48 government secondary schools, the rest being private.[1]

Secondary education is mainly financed by private groups such as religious organizations, industrial bodies and municipalities. Also, high schools are very well-developed in towns and in industrial areas while the schools of the village areas are largely neglected.[2] However, it has been mentioned in the previous chapter that the minority groups of industrialists and traders

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[1] Chief Minister's Secretariat, pt. 2, (1957), pp. 4-5.

[2] Planning Board, The First Five Year Plan, II, (1956), p. 408.

appropriate a major part of the national income most of which comes from the agriculture of the village areas. Such an inequality of educational opportunities and the consequent fostering of the minority group are incompatible with the values of social democracy. To cite one of the many examples, ineqaulity of educational background among different geographical groups may hinder cooperation among them. Furthermore, it is evident from the foregoing that many rural schools are unable to provide adequate libraries, laboratories and science museums which can be easily maintained by the urban schools and other schools financed by industrial bodies.

Inequalities of Facilities. The matriculation examination for which all secondary schools prepare candidates is a battery of achievement tests. A fair appraisal of student ability judged from achievement on these tests, must assume comparable educational backgrounds. But, as will be shown, there are great differences in the scientific experiences offered students in the secondary schools of East Pakistan.

Although general science is a compulsory subject for classes six through eight,[3] it is a very neglected subject throughout the secondary stage. As an example,

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[3]Government of Pakistan, Proceedings of the Fifth Meeting of the Advisory Board of Education for Pakistan Held at Bahawalpur on 4th and 5th March, 1953, (1955), p. 18.

it has been shown in the introductory chapter that lack of continuity and uniformity exists in the science program offered by different secondary schools and science instruction in them is mostly verbalistic and non-functional.

Moreover, science is one of the three optional subjects for the matriculation examination. The relative percentages of students in the sixth through tenth classes are 28.2, 22.5 19.5 15.2 and 14.6. In the year 1954-55, the total enrolment in the tenth class was 48,650.[4] Also, during the years 1956 through 1958 only 4858 students on the average appeared in the matriculation examination with science as an optional subject.[5] Thus, on the average one in eleven tenth class students take the science section of the matriculation examination.

Due to the lack of minimum laboratory equipment and due to a dearth of science teachers many schools cannot offer science to their students. It therefore seems that those students who appeared in the matriculation examination with science as an optional subject had at least the facilities for science study in their schools. The main function of optional science courses is to increase the total grade of the examinees. For example, a student who secures 70 in the science examination gets an increment

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[4]Chief Minister's Secretariat, op.cit., p. 7.

[5]Data collected from the office of Secondary Education Board, Dacca, by air mail correspondence.

on his total compulsory subjects grade of 70-30 = 40, 30 being the minimum grade for passing the examination. Also, a student who secures any grade below 30 in the science examination is not detained provided he passes all the compulsory subject examinations. This means that the plan of increasing the total grade by taking the additional science examination is without risk to the student. As a result, most students getting the opportunities for science study may try this plan because an increase of the total grade increases the probability of obtaining a scholarship. Consequently, the probability of obtaining a scholarship is greater for those students who have had better opportunities for science education. Thus the rich locality continues to be richer in educational facilities and the poor to become poorer in getting education. When this analysis is considered in the light of the fact that the majority of the East Pakistanis is very poor, it demands equitable distribution of science education throughout the country.

In the year 1950, 1150000 rupees[6] were placed at the disposal of the Directorate of Education, East Pakistan for distributing them as scholarships among academically gifted students.[7] Today the amount of money for scholarships has increased considerably. Consequently, competition for

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[6] About 4.8 rupees = $ 1.

[7] Government of Pakistan, Proceedings of the Fourth Meeting of the Advisory Board of Education for Pakistan Held at Lahore from 29th November to 1st December, 1950, (1950), p. 47.

securing high marks in the official examination has increased. Such competition may produce attitudes of pseudo-superiority among top-ranking students and isolate them from the hard realities of their lives. These students usually come from families of higher economic status and their parents can easily afford for educational opportunities for them. Also, scoring high marks in the examination brings them extra money of scholarships. The needy but meritorious students on the other hand, are usually being deprived of such scholarships because they scarcely have had requisite educational facilities for winning the scholarship. As a result, they may develop attitudes of inferiority and lose self-confidence. Thus, their potential academic efficiency is nipped in the bud.

Recommendations. The scholarship-winners are usually better-placed in their worldly life. They should be asked to repay the entire amount of scholarship money received by them. The money may be returned to the government by suitable instalments as determined by the students' income after graduation. In this way, the gifted students may be made more responsible for their obligations to the country.

To achieve the foregoing a law should be passed by the government of East Pakistan since education is a subject of the province. The Central Government helps the provincial government in materializing its educational

plans by providing financial aid and loans, and by coordinating educational policies. Having passed the law the provincial government of East Pakistan may ask the Central Government for a loan of an amount equivalent to that which can be realized from the scholarship-holders. This amount can be equitably distributed among ill-equipped secondary schools for improving their laboratories, libraries and audio-visual aids. Moreover, this government aid may increase local interest in education. Thus, the aid can be supplemented by a corresponding amount collected as a subscription from the respective locality.

It is very interesting that educational broadcasts, films service and science museums have been recommended by leading educators.[8] These teaching units have been discussed in the sections of recommendations immediately following. Moreover, their maximum benefit can be obtained if science instruction is made compulsory for classes nine and ten also. It is therefore recommended that science be a compulsory subject in the matriculation examination of East Pakistan. "Practical work such as the preparation of simple apparatus models for science projects and laboratory experiments should be compulsory in secondary school science courses."[9]

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[8] Government of Pakistan, Proceedings of the Second Meeting of the Advisory Board... at Peshawar from 7th to 9th February, 1949, (1949), pp. 64-68.

[9] See recommendation No. 2 in Appendix B, which was deemed desirable by the science educators responding to the questionnaire.

Administrative Control

The Director of Public Instruction in cooperation with the Secondary Education Board and a Textbook Committee controls the secondary schools of East Pakistan. The Board prepares syllabi and the Committee selects textbooks written for secondary education following the syllabi. The Board also issues instructions for improving curriculum and supervises the schools through inspectors. On the recommendation of the inspectors the Board offers recognition to private secondary schools for sending their students to Matriculation examinations. All private schools are financed by local bodies usually with meagre financial aid from the Director. A local school body is elected by the people and is authorized to appoint the teaching staff.

The few government schools are financed by the Director who also appoints the teaching staff. The headmaster of any secondary school remains responsible to the local inspector for the administration of his school. Teachers are responsible to the headmaster for the improvement of their teaching techniques. Usually, the headmaster helps his teachers in improving their instruction.

Unfortunately, the relation between an inspector and teachers of private schools often becomes dictatorial

mostly because the inspector derives his authority from the Government while the teachers do not possess such governmental authority. This dictatorial relation tends to be extended between a teacher and his students in the class-room. The main defect of the dictatorial system of administration is that the higher authority issues orders which are followed almost blindly by the lower authority who might have a better idea related to the issue. In consequence, the lower authority may become either a rebel or his initiative and self-responsibility are suppressed.

The Chairman of the East Pakistan Public Service Commission has suggested that the headmasters of all recognized private schools should be government servants.[10] Such an extension of the governmental control over private schools may strengthen the dictatorial bonds in the secondary schools. The resulting curtailment of the responsibility of the local school body may be followed by a corresponding lessening of peple's interest in the schools. All these consequences seem to contradict the suggestion, "Secondary Education should be the responsibility of the local bodies with adequate government help."[11]

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[10] Chief Minister's Secretariat, Report of the Educational Reforms Commission: East Pakistan, pt. 2, (1957), p. 77.

[11] Ibid., p. 33.

What is needed under the existing conditions of East Pakistan is a headmaster who is well-qualified in sound theory and methods of modern education in a democracy. His personality should command the respect and confidence of his teaching staff and of the people of the locality of his school.

Recommendations. Instead of requiring a headmaster to be a government servant, he should be required to have a minimum of one year's training at a teacher college. With the advance of education in the country the period of his training may be increased to include theory and practice of school administration. The trained headmaster should be able to suggest improvement in the teaching methods adopted by his staff. If his staff is mostly untrained, he should provide professional literature and guide them to acquire essential knowledge and the skills of modern teaching techniques. This function of the headmaster may also help the further professional growth of teachers in a school where the teachers are mostly trained. The headmaster may carry out discussion on methods of teaching and lecture the untrained teachers in weekly faculty meeting.[12] In this meeting teachers may plan for cooperative teaching units, classification and promotion of students, and improvement of evaluation.

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[12] It is interesting to note that the East Pakistani science educators included in this study were unanimous in expressing a desire to hold such meetings regularly. See item 17, Appendix B.

In establishing democratic and friendly relations between inspectors and teachers, the inspector may be given the role of a coordinator. He can distribute expensive apparatus, audio-visual materials, reference books and professional literature by rotation among several schools located near to each other.[13] Such a distribution should be preceded by an analysis of the teachers needs and plans. This cooperative planning between inspectors and teachers may make the teachers feel more respected and responsible for their jobs. In this administrative activities the following suggestions of Luther E. Bradfield[14] should be followed in the schools of East Pakistan.

Supervision should be under democratic leadership. The leader must respect the personality of each member and encourage working together for common purpose. Group participation will provide for creativity and feeling of self-importance on the part of every member in making group decisions. The supervisor, inspector must create an atmosphere for maximum cooperation, creative group planning and activities for solving problems and directing the educational processes. Efficacy of group work should be determined by group evaluation.

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[13] This is in accordance with the recommendations 3, 4a, 4b, 10 and 15 in Appendix B. Statistical analysis of the reactions of these science educators shows that they are favorable to this concept of a "rotating laboratory-library".

[14] "Eight Suggestions for Basic Principles Underlying Techniques of Supervision", The American School Board Journal. A Periodical of School Administration, (June, 1954), pp. 21-23.

In supervisory leadership good human relations should be fostered. Supervisor should understand the personal problems of teachers and sympathize so that they feel secure and free to express themselves. He should evaluate and respect their honest views and contributions. Also, he should stimulate and inspire continuous professional growth and study of teachers through self-analysis, criticism and evaluation. He should encourage research and experimentation in order to set free teachers' initiative, originality and creativity for their continuous self-improvement. Thus prescribed curriculum can be adapted to local conditions and and needs by discovering suitable methods and materials for teaching.

The aim of supervision is to furnish optimum help in all phases of teachers' activities. The extent of such help depends upon the experience and qualification of the teacher. In adapting the helping techniques to a teaching-learning situation the supervisor must consider its all aspects. Supervision should not be a rigid routine procedure.

Through cooperative effort the supervisor should attempt at improving the physical and psychological environment of teaching-learning process. The physical environment includes school plant with its classrooms, library, laboratory and so on while psychological environment consists of teacher-pupil relations. Furthermore, he should be ready to help the group as well as its individual in a variety of situations.[15]

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[15] Ibid.

Interestingly enough, all the science educators included in this study have opined that the headmaster should help his science teachers to maintain pleasant student-teacher relationships.[16] Thus it is needed that the friendly relation between a supervisor and teachers should be extended directly to influence teacher-pupil relation. It means that the science teachers may well accept the suggestions of Luther E. Bradfield in delegating a share of his responsibilities to his students according to their capacities.

Science Facilities

To materialize the compulsory science program in the secondary schools of East Pakistan, minimum facilites in science rooms, audio-visual aids, science clubs and libraries are essential. Without these facilities, efficiency of science instruction cannot be maintained at optimum level. Hence, follows the need for the discussion of the nature of the facilities which have been taken up in the following recommendations.

Recommendations. For the convenience of discussion the subsequent recommendations have been classified under "Science Room", "Audio-visual Aids", "Science Club", and "Library". In practice, such classification may not

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[16]Recommendation No. 14 in Appendix B.

exist. In many schools, which are unable to provide more than one science room, it is desirable to hold club meetings in science classroom where audio-visual aids and science references can also be kept in the corners.

Science Room Recommended.[17] If possible a school may provide separate rooms for advanced courses in physics, chemistry and biology. To avoid daily transfer of equipment and apparatus it is convenient to use one suitably large room for laboratory and classroom work. To facilitate the use of chalkboard and other demonstration equipment, the room should have a nearly square shape. Practicable shape and size of the room should be planned cooperatively by experienced science teacher, supervisor and architects. Usually, the room should provide accommodation for all students of a section (about 20-30 students).

A science museum should be adjacent to the science room. Only those things which have educational value should be kept in the museum. All specimen and objects of the museum should be labelled, carefully preserved and recorded in an inventory by students and teachers working cooperatively. Moreover, there should be a general record book for all materials and equipment of the science room.

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[17] Developed in accordance with recommendation nos. 2, 7 and 9 in Appendix B. All these recommendations are favored by the science educators included in this study.

> The keynote of modern design for science rooms is flexibility. Modular units and moveable desks, shelves, worktables and chairs are highly desirable. Ideally, a science room should include provision for the total offerings of a science course, including discussion, lectures, demonstrations and experimentation. It should have adequate storage space and workshops adjoining it. [18]

Also, heat and water supplies, chemicals, working tools--vise, hammers, saws, pliers, drills, wrenches, etc., raw materials--wood, tin, glass, wire, copper, etc., should be easily available to students. In absence of a dark room students may take advantage of the darkness of the night.

Audio-visual Aids Recommended. The suggestion for the use of inexpensive audio-visual materials has been accepted by the leading science educators of East Pakistan.[19] Such inexpensive materials may include homemade apparatus, models, graphs, charts, photographs, diagram, specimen and community materials. Moreover, radio broadcasts should form an integral part of the curriculum in close cooperation between the Radio Pakistan and the educational authorities. The school broadcast can be planned for 1 or 2 classes of students listening at a time under the guidance of a teacher.[20]

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[18] R. Will Burnett, Teaching Science in the Secondary School, (1957), p. 211.

[19] See recommendation No. 4a in Appendix B.

[20] Government of Pakistan, Proceedings of the Second Meeting of the Advisory Board of Education Held at Peshawar from 7th to 9th February, 1949, (1949), p. 64.

Now, the Secondary Education Board is in charge of improving instruction, and radio and films are practical aids to teaching. The Board could meet a definite need by sponsoring radio programs integrated with the science syllabus of the Board. Furthermore, it could distribute educational films and filmstrips through school inspectors.

Since imported films cannot cover all aspects of our education the Government of Pakistan should establish a Central Educational Film Service.[21] Some foreign film agencies send their catalogs on request. These catalogs provide valuable information about science films and filmstrips. The Pakistan Film Service may get those catalogs and purchase some foreign films for translation and for getting new ideas in planning educational films for the secondary schools. To this end a list of the film agencies has been given in Appendix E.

Several research studies provided evidence to the effect that when carefully selected for teaching appropriate age-groups, sound motion-picture film can increase learning in science up to 22-30%.[22] Also, teaching through films has been found to increase retention of scientific knowledge by from 9 to 38.5% over a limited period of time.[23]

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[21] Ibid., p. 66.

[22] Walter Arno Wittich and Charles Francis Schuller, Audio-visual Materials. Their Nature and Use, 2nd ed., (1957), p. 392.

[23] Ibid., p. 394.

Moreover, films can bring physically inaccessible reality in the classroom and consequently make learning more vital. For example, Encyclopedia Britannica Film Company has produced a physics project with 162 half-hour lecture demonstrations and laboratory sessions featuring a physicist, Harvey White as a teacher.[24] By virtue of motion pictures this expert teacher is now available to any science classroom. Science teachers can get new ideas of teaching from H. White's master techniques of instruction. Moreover, such things are the growth of plants and the bottom of ocean can also be represented by motion picture in the secondary schools of East Pakistan.

At present, most secondary school plants do not have adequate dark-room, power supply and projectors for motion-picture films. It is, therefore, recommended that local cinema houses or darkness of the night can be utilized for educational film shows. Moreover, school inspector in cooperation with local school bodies and teaching staffs can circulate travelling projection equipment such as screen, battery--fed projector, film and filmstrips. In selecting any audio-visual material for teaching purpose the following questions should be asked:

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[24]Carlton Smith, "Physics Film Course Aids Science Education", Education Screen and Audio-visual Guide, (March, 1958), p. 126.

> Do the materials give a true picture of the ideas they present? Do they contribute meaningful content to the topic under study? Is the material appropriate for the age, intelligence and experience of the learners? Is the physical condition of the materials satisfactory? Is there a teacher's guide to provide help in effective use of the materials? Do they make students better thinkers, critical-minded? Do they tend to improve human relations? Is the material worth the time, expense, and effort involved? 25

Science Club Recommended. A club is a means for students' social development, stimulation of their interest and organizing ability. It makes school learning vital and meaningful. It is very interesting to note that the suggestion for a science club and its various functions has been welcomed by leading science educators of East Pakistan. For example, the recommendations, "To study science related problems of East Pakistan, students from rural schools should occasionally take educational excursions to urban areas and vice versa" and "Every school should provide facilities for organizing students' science associations. The functions of such associations should be to organize educational excursions, exhibitions, special lectures and debates on science topics as well as subscribing to and sometimes publishing science magazines," were well supported by the science educators who responded to the questionnaire.[26]

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[25] Edgar Dale, Audio-visual Methods in Teaching, revised ed., (1954), p. 83.

[26] See the recommendations 5 and 6 in Appendix B.

Sometimes parents may be invited for special lectures, debates and exhibitions. Thus some ignorant parents may learn scientific information about health and conservation. How to start such a club is illustrated below.

A science teacher asked his students to express their interests and hobbies. On the basis of interests shared by a group of students, several committees named "animal committee", "fish committee", "plant committee", etc. were formed. The teacher guided the committees to make plans for their meeting and activities. The committees were sometimes asked to present the report on their activities or projects in the class.

According to needs, the students wrote letters to different companies for sending their free materials for the club. Letters, booklets, wall charts, comic science books, posters, models, displays, film strips, information about aquariums, animals, rocks, insects, railroads, steel and conservation were received. Some parents donated furniture for the club. The club became interested in tropical fish which were extensively studied by reorganizing the activities of the club, and by collecting references from the public library about aquariums and tropical fish. Experimentation continued. Aquatic plants and animals were studied simultaneously

with tropical fish. Students learned to take care of animals and to write stories about them.[27]

Science Library Recommended. An improved science program needs a science library filled with variety of reference books for both science teachers and students. Also, the librarian should keep the teacher and students informed of the up-to-date references available in the library. The suggestion that the Education Directorate should supply reference books and pertinent publications to every secondary school was favorably received by the respondents to the author's questionnaire.[28] The lists of reference books and literature for science teachers and students are provided in Appendixes C and D respectively. A group of expert science teachers may translate the books with suitable modification for use in the secondary schools of East Pakistan. In selecting a reference book for the secondary school students the following criteria may be used by the Textbook Committee of East Pakistan.

> It provokes thinking and discussion. It develops interest in matters of science. It stimulates further reading. It helps to articulate and elucidate scientific concepts and principles. It suggests further problems. It gives insights into social implications and contributions of science... It is accurate and authoritative. It

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[27]Gilbert Benowitz, "Science Club in the Making", Science Education, (April, 1956), pp. 228-232.

[28]See Recommendations 10 and 15 in Appendix B.

> is fair and sincere in its presentation of controversial subject matters. Its enrichment material goes beyond that of secondary textbooks. It has good literary standards--clear style, grammatically correct, easy to read. Its general theme and tone are wholesome. It is a book of lasting value--one worth owning and going back to. 29

Educational Guidance

Most educated people of East Pakistan feel an urgent need for educational guidance so as to reduce large scale failure in the official examination.[30] This feeling of the people is harmonious with the value of social democracy, equal educational opportunities for all according to innate potentialities of the learner so as to make optimum use of available resources for the benefit of the society.

In such a guidance program the importance of scholastic aptitude tests is indicated by the fact that success in both physical and biological sciences is significantly correlated with the results of any one of the tests in verbal reasoning, numerical ability, abstract reasoning, space relations, mechanical reasoning, clerical speed and accuracy, spelling and sentences.[31] This

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[29]Cyrus W. Barnes, et al., "Criteria for Selecting Supplementary Reading Science Books for Intellectually Gifted High School Students", Science Education, (April, 1958), p. 217.

[30]Chief Minister's Secretariat, p. 30.

[31]Edwin E. Vineyard, "A Longitudinal Study of Differential Aptitude Test Scores with College Success", The Personnel and Guidance Journal, (February, 1958), pp. 413-16.

finding has been confirmed by another study.[32] From the definition of significant correlation it follows that a certain level of predication of success in the science courses is possible from these test results.

Recommendations. Thus, in developing a sound program of educational guidance secondary schools of East Pakistan should keep cumulative records of each student's aptitudes. Further information to be included in the record are achievement in different subject areas, health conditions, character traits such as industry, cooperativeness, etc., personal interests and ambitions, attitudes, socio-economic conditions of parents, parental ambitions and interests.[33]

Having secured the foregoing, students may be classified by a group of experienced educators just at the beginning of class nine when specialization is allowed in the schools of East Pakistan. Of course, such classification should be flexible enough to allow transfer of misplaced students from one group to another. Different groups may be offered advanced courses in physics, chemistry, and biology as determined by their aptitudes, interests and local needs. Also, the school graduates may be followed up in order to improve the guidance program of the school in later years.

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[32] James N. Jacobs, "Aptitude and Achievement Measures in Predicting High School Academic Success", The Personnel and Guidance Journal, (January, 1959), pp. 334-41.

[33] J.B. Edmonson, et al., The Administration of the Modern Secondary School, 4th ed., (1953), pp. 191-93.

Science Teachers

An improved program of science education necessitates qualified science teachers because in the hands of a well-qualified teacher a narrowly prescribed syllabus can become life-like and meaningful while an unqualified teacher cannot make even the most vital and meaningful syllabus a functioning one. At present, about 15% of the secondary school teachers are trained in teacher colleges.[34] The percentage of trained science teachers is actually fewer than the above figure, however, because in most secondary schools an untrained science graduate gets the same salary as a trained arts graduate. This is because the science graduates are usually employed in industrial firms where salaries are higher than that of a school teacher. Still more deplorable becomes the condition of the school when the science teacher receives an offer of a job from such firms. In that case the teacher may send a resignation letter to the school authority and accept the new job.

East Pakistan has two universities, one in Rajshahi and another in Dacca. In 1958, the Rajshahi University offered the Bachelor of Science degree to 105 students.[35] Slightly more than 105 science graduates

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[34] Chief Minister's Secretariat, Report of Edl. Reform Commission, East Pakistan, pt. 2, (1957), p. 4.

[35] The Pakistan Observer, (August 26, 1958), p.3.

came out of the Dacca University every year. In both universities a science graduate has to study three organized branches of science such as physics, chemistry, biology or mathematics for four years. Of course, during the beginning two years English and native language are studied along with the science subjects. After graduation a student may continue his Master's degree work in any one of the three subjects he studied. A few science graduates enter training college and undergo one year teachers' training for B.T. degree.

Under the existing conditions of economic crisis in East Pakistan, most science graduates, who have to earn their livelihood, find it very difficult to undergo additional one year's training in a teachers college. Moreover, the training colleges being located far away from any general college for arts and sciences, post-graduate teacher's training is beset with adjustment problems in a new locality such as food, shelter and friends.

Recommendations. "To increase the number of trained science teachers, teacher's training courses should be offered, as optional subjects, simultaneously with undergraduate science courses in suitable degree colleges." This recommendation was favored by the respondents to the questionnaire.[36] Moreover, it is

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[36]See recommendation No. 13 in Appendix B.

psychologically sound because distributed learning (throughout) several years of graduate study) is better than massed learning[37] (one academic year's training in teacher college).

The recommendation, "Practical work such as the preparation of simple apparatus, models for science projects and laboratory experiments should be compulsory in secondary school science courses" was favored by the respondents to the questionnaire.[38] This implies that the new training courses should include workshop practices in the preparation of simple demonstration equipment such as batteries, lenses, aquariums, terrariums, etc. However, to keep this thesis within its scope, only a brief outline of teacher's training courses is given below.

During the last two years of graduate work one-third of the total college hours should be devoted to the study of professional education. The remaining two thirds of the college hours should be used for the continued study of two of the organized branches of science (physics, chemistry or biology). The professional training courses may include objectives and methods of teaching the two science subjects taken up by the student teacher, sociological aspects of the two subjects, some teaching practices in these subjects, and psychology and philosophy of education.[39]

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[37]Norman L. Mum, Psychology, 3rd ed., (1948), p. 249.

[38]See recommendation No. 2 in Appendix B.

[39]Annoted from W. Freeman Galpin, Syracuse and Teachers Education, The First Fifty Years, (1956), p. 11.

To teach educational psychology and philosophy in the new program of teacher education, the professors of psychology and philosophy departments of the degree college may be employed part-time. Also, the science graduates having two years' post-graduate training in pedagogy can be employed to teach the rest of the said training courses. This may be the starting point for the introduction of the training courses in suitable degree colleges of East Pakistan. As the conditions of education in the country improve the requisite qualification for such professorships can be modified and extended. Moreover, the training courses may be revised and extended to include school administration, guidance and other subjects as determined by the then needs of the country. All these professional preparation for prospective science teachers are expected to increase their self-confidence and competencies in teaching science.

Furthermore, most teachers are socially mature, that is, they may consider remote reward, a pensionable service to be more valuable than immediate reward, an equivalent increment in their present salaries. As a result, a job with graded increment in salary and then pension, is more attractive to them than another with a fixed salary as is the case in almost all private secondary schools of East Pakistan. Hence, to attract

science graduates to the teaching profession, as well as to keep them in service, teachers' salaries should have annual increments and pension at the completion of service in all private secondary schools of East Pakistan. Also, the salaries of science teachers should be fixed according to their qualification; such a service will provide reasonable security needed for the efficiency of teaching.

Moreover, academic freedom for science teachers as offered in democratic supervision may keep many freedom-loving young teachers in the teaching profession. Hence, academic freedom for science teachers is strongly recommended, not only because it is the sin qua non for effective teaching, but also to attract and keep capable teachers.

CHAPTER IV

ANALYSIS OF SCIENCE SYLLABI AND TEXTBOOKS OF THE SECONDARY SCHOOLS OF EAST PAKISTAN

In spite of the invention of many modern audio-visual aids to teaching, the textbook is the main medium of today's teaching-learning process. In East Pakistan where most science teachers lack training in the methods and materials of teaching, the prescribed science textbooks are the chief tools of their teaching. These textbooks are written around the prescribed curricula, the official syllabi of the Secondary Education Board. Thus, in the program of science education the syllabi and the corresponding textbooks are very important factors which have been analysed in this chapter.

Science Syllabi

The purpose of this analysis is to discover the developmental sequence in the science content of the syllabi. In this analysis, the deficiencies of the curriculum in terms of students' growth in understanding scientific problems of East Pakistan have been pointed out. Finally, some suggestions to remedy the weaknesses found from the analysis have been proposed.

The science syllabi for classes six through ten were secured from the office of East Pakistan Secondary Education Board. The content of the syllabi have been classified in terms of major areas of physics, chemistry and biology in table I. There is a separate syllabus for each of the classes six, seven and eight, and one for classes nine and ten. The vertical column shows the content of each syllabus of a class or classes indicated in the column heading. The horizontal row shows the distribution of the content of a given area of a science subject, e.g., heat and magnetism of physics. However, in the last row and the column under class eight, the content--traffic accidents drowning and sunstroke--could not be better fitted in the table. The justification for putting them in the area of biology is that their treatment in the form of "Safety and first aid" is emphasized in the syllabus. Thus the emphasis is on the care of human life which is an aspect of biology.

In the area of heat under physics, the content covered during the first three years of the secondary stage are repeated in the syllabus for the last two years. Such repetition may help to establish the basic concepts in the learner. But this repetition should be in a form which is challenging enough to stimulate the learner's advanced mental abilities. In other words, such repetition should be accompanied by broadening the

TABLE I

DISTRIBUTION OF SCIENCE CONTENT THROUGHOUT THE SECONDARY CLASSES VIZ. SIX THROUGH TEN

Areas of Physics	Class VI	Class VII	Class VIII	Classes IX and X
Heat	Expansion of solids, liquids and gases with examples and application in bridge railroads, etc. Change of state, melting, boiling, evaporation, freezing, condensation, clouds, rains; rain-gauge, fog and dew.	Temperature, its measurement and thermometers of different kinds	Conduction, convection and radiation; thermoflask, icebox and refrigerator	Expansion of solids, liquids, gases; temperature and thermometers; melting and boiling points; conduction, convection and radiation; specific heat; change of states.
Static Electricity	Attraction and repulsion of charged body; the spark and sound produced by dry hair, thunder and lightning.		Precaution against lightning	Electrification by friction; positive and negative electricity; properties of charged body, conductors and insulators; electroscope.
Current Electricity			Simple voltaic cell; good and bad conductors of electricity; simple effects of currents, electric lamp, battery, iron, stove, electromagnet and bell.	Simple voltaic cells, effects of a current, electromagnets, electric bell, simple principles of telegraphy. Later added torches, sources of electric supply in towns; circuits. Types of current (A.C. and D.C.)

TABLE I
(Continued)

Areas of Physics	Class VI	Class VII	Class VIII	Classes IX and X
Magnetism				Attraction and repulsion; natural and artificial magnets; terrestrial magnetism, magnetic meridian, the compass.
General Physics	Ventilated and non-ventilated food containers, meat safes,	Force of gravity, weight balance, the earth and its characteristics; the solar system and the milky way.	Air pressure, barometers, siphon, pumps, fountain-pen fillers, air bladder in fish, water tank in submarines. Archimedes' principle and its application.	Three states of matter measurement of length, area, volume and time; velocity, acceleration force, mass, weight, the balance; density, specific gravity, Archimedes' principle, pressure of air, simple barometer, energy and conservation of energy.
Sound Light				Nature of sound, its production of transmission. Ractilinear propagation of light; illumination, Laws of reflection and plane mirror; refraction, use of concave and convex lenses; prisms and white light, color

TABLE I
(Continued)

Areas of Chemistry	Class VI	Class VII	Class VIII	Classes IX and X
Inorganic Chemistry and Physical Chemistry	Solutions; soluble and insoluble soil materials; filtration. Making salt from saline water, solution of shallac in spirit and its use. Boiling of milk for pasteurization; elimination of impurities and cleanliness of dishes and containers of food.	Preservation of food, clothing and related materials through canning, drying, refrigeration, wood and metals-painting and protecting coats, protection against rot, corrosion termits and beetles. Sources of water, its purification and control against pollution, flood; Tube and Dug wells.	Elements, compounds, mixture, distillation, sublimation, crystallization. Burns and poisoning.	Scope of chemistry, elements, compounds, mechanical mixture, solutions, filtration, crystallization, distillation and sublimation. Atoms and molecules; chemical combinations-burning candle and sulphur in air, heating mercuric oxide and potassium chlorate Acids, bases and salts Air, its composition, preparation and properties of hydrogen, oxygen and nitrogen. Water, its composition, hard and soft water. Properties and uses of iron, zinc and sulphur
Organic Chemistry	Making solution of coaltar in kerosene	Ingredients of soap and home soap production	Organic waste disposal, pit disposal systems, septic tank disposal system, trench disposal of garbage, burning.	Study of carbon, its uses; preparation of carbon-dioxide and its properties. Foods--their relative values and their essential ingredients.

TABLE I
(Continued)

Areas of Biology	Class VI	Class VII	Class VIII	Classes IX and X
Botany	Parts of plants and their life process. Care of plants-application of fertilizers, protection against natural enemies and diseases, dormant and growing seasons; control of mold and mildew;common plants of foreign countries. Importance of plant life.	Flowers--its parts; germination of pea-seeds, formation and disposal of seeds; Agriculture and farming equipment.		Structure of a common flowering plant; functions of root, stem, leaf, flower and fruit. Special characteristics of living locomotion, respiration, nutrition growth, response to stimulus, propagation and death; adaptation to environments; examples from plants like rice and pea with their life histories.
Biology	Control of insects, flies, ants and cockroaches. Similarities and dissimilarities in animals and plants.		Care of domestic animals, their feeding, protection against common diseases, accidents, malnutrition;livestock improvement thru breeding, common forms of foreign animals. Safety and first aid--traffic accidents drowning and artificial respiration, bleeding, fainting and sunstroke, snakebite, wasp, scorpion-bites and their treatment;fracture; care of ear, nose and throat.	Adaptation to environments, examples from animals like earthworm and fish. Life history of ant, bee, spider, mosquito, butterfly and frog--interdependence of plants and animals. Simple consideration of the human body and its principal systems, via circulatory, respiratory and digestive systems; functions of the skin and nerves.

scope of the content. Content which is a mere repetition of already covered ideas may produce boredome and dislike in many students who are ready to study more advanced science materials.

In the second row of static electricity, attraction and repulsion of charged body is the content of class six syllabus while electroscope appears in the syllabus for classes nine and ten. In a meaningful study of attraction and repulsion of charged body, the laws of attraction and repulsion should be studied inductively. In this inductive study of the scientific generalization, the said laws, the use of electroscope or similar instrument is essential. Thus the electroscope should be included in the syllabus for class six and the subsequent vacuum in the syllabus for classes nine and ten can be filled with electrophorus or similar electrical machines. Moreover, to provide continuity in students' understanding of the physical environment, the full blank in the area of electricity in the syllabus for class seven should be occupied by simple electrical appliances such as torches, tele graphy, etc. which are now in the syllabus for classes nine and ten. The consequent gap in the latter should be filled with galvanometers, ammeters, voltmeters, radio, etc.

It is generally known that the first interest of a child grows in moving things and gradually his interest broadens to include static and abstract materials. According to this growth of interest, the psychological arrangement of the content in electricity should start with current electricity which is now in the syllabus for class eight.

Thus it seems from the table that the content in the areas of electricity is not organized psychologically. Furthermore, magnetic attraction and repulsion which the syllabus calls for in classes nine and ten could be easily taught in any lower class, preferably along with electric attraction and repulsion.

In the area of general physics some sort of continuity in the distribution of content, as in the area of heat, is marked. But the large blank in the areas of sound and light in the syllabi for classes six through eight is incompatible with the objective, as stated in the introduction to those syllabi, "An understanding of Science as a way of life to those who do not propose to take more defined courses like Biology, Chemistry and Physics in future." In order to understand life, the students must understand their physical environment which includes light and sound. Moreover, the environment has within it many types of machines. Thus it seems desirable to have light and sound in the syllabi for classes six through eight, and lever, pulleys, engines, etc., in the syllabus for classes nine and ten.

As for the area of heat, some sort of developmental sequence can be identified in the areas of chemistry as a whole, viz. the areas of general and inorganic chemistry, and organic chemistry when considered together. However, the content of these areas seems deficient in simple knowledge of the manufacture of fertilizer, cement, paper,

cosmetics, fuels and dyes, qualitative analysis, diffusion, gas laws, etc. which are essential for understanding everyday phenomena of East Pakistan. Similarly, the areas of biology as a whole show some sort of continuity but are lacking in many content areas, e.g., many plants commonly found in East Pakistan, genetics and psychology of human behavior which are essential for understanding the environment.

Finally, the syllabi for classes six, seven and eight contain instructions to the effect that authors of science textbooks should organize the materials on the basis of the official aims of Secondary Education of which the development of social and civic responsibilities in the students is very important. Also, the authors are instructed to provide hints for teachers regarding class-teaching procedures at the relevant places of the text. A careful analysis of the prescribed textbooks shows deficiencies in the said aims and in hints for teaching procedures. However, an account of the analysis of the textbooks is given in the next section.

Recommendations. The details of a science curriculum for the secondary schools of East Pakistan should provide for a continuity in students' understanding of scientific knowledge and methods. As a student passes from class six to ten, he will have to learn gradually more and more difficult science materials. Easy science

content should be included in the syllabi for lower secondary classes and difficult science materials should be the content for higher classes. The content such as late-communication devices, cinema, photography, machines, etc. which are essential for understanding the environment should be included in the syllabi for the upper secondary classes. Moreover, any repetition of a scientific concept in the syllabus for higher classes should be followed by a corresponding broadening of its scope adjusted to the students' levels of comprehension.

The following brief outline of the science curriculum of the U.S.S.R. as reported by U.S. Office of Education seems to meet the above criteria, and is, therefore, recommended for classes six through ten in the schools of East Pakistan.

In Soviet schools biology includes classification of plants in sixth grade, physiology of man, hygiene and sex instruction in seventh and eightth grades, basic concepts of organic evolution in ninth grade, and general psychology and main concepts of logic in tenth grade. Physics covers mechanics and hydrodynamics in sixth grade, heat, light and electricity in seventh grade, mechanics, kinematics, dynamics, statics, heat, light and electricity in eighth grade, molecular physics and heat in ninth grade, and electricity, optics, sound and aerodynamics in tenth grade. Chemistry provides basic concepts of elements,

molecular structure, oxides, salts and weight relations in seventh grade, explanation and application of chemical phenomena in eighth and ninth grades, and introductory organic chemistry in tenth grades.

In the sixth and seventh grades laboratory experiments and summer projects are assigned; these are recorded by students and science clubs are integrated with class work. In the remaining three years most sciences are devoted to agriculture, industry and life in Soviet Russia.[1]

To realize the foregoing, East Pakistan Secondary Education Board, the curriculum maker should select a group of science experts to prepare the detailed syllabi for the five secondary classes. The body of experts should comprise experienced high school science teachers, specialists in such fields as health, agriculture and industry of East Pakistan and scientists representatives of physics, chemistry and biology. This cooperation among scientists, community experts and science teachers is expected to increase communities' interest in science education of the secondary schools.

Interest makes one a more serious and efficient learner. Sustained interest of the learner arises from satisfaction of his felt-needs or vital problems such as

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[1]Adapted from Ellsworth S. Obourn, "Sciene and Mathematics in the Soviet Ten-Year School", School Science and Mathematics, (October 1958), pp. 515-17.

an understanding of the physical environment in order to lead a life harmonious with its laws, solving food problems, fuel problems and so on. Thus to take advantage of the students' interest, some suitable content of general science should be organized around the vital problems of East Pakistan. Further discussion of this issue is taken up in the last section of this chapter.

However, many science materials such as scientific events of the past may not be related to the present-day problems of East Pakistan. Some of the events and issues of science from the past should be comprised in the syllabi in order to widen the intellectual horizon of the students and to build their appreciation for scientists and their works. This discussion is taken up again in the recommendations of the section immediately following.

Today's science has provided scientific interpretations of many unfounded popular beliefs known as superstitions. Correction of students' superstitious beliefs in the light of scientific evidences is essential for "An understanding of science as a way of life". Thus it seems necessary that the Secondary Education Board should collect a list of prevalent superstitious from the experienced teachers of different districts of East Pakistan and ask the textbook writers to provide scientific explanation and suggest scientific experiences related to the superstitions.

As an example, if the secondary school students believe that touching tadpoles produces warts, the author of a biology unit may suggest some experiments involving handling the tadpoles, studying the effects of this handling and then seeking scientific interpretations in terms of causation in contrast to concommitances.

Science Textbooks[2]

In this analysis certain weak points of the science textbooks have been pointed out with a view that their next edition can be made free from those weaknesses. Also, some ways of remedying the weaknesses have been suggested. Of course, the recommendations proposed here are not exhaustive. In order to limit this study within its bounds, exhaustive recommendations have not been aimed at.

Three textbooks for classes six through eight have been written under cooperative authorship, that is, two or more authors contributing to the same textbook. But the single textbook for classes nine and ten has been written

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[2]Muhammad Ferdans Khan, et al., Biggan Mukul, (Science of Flower), (1957), East Pakistan School Textbook Board, Dacca. Prescribed for class six.

[2]M.A. Ajam, et. al., Shahaj Biggan, (Easy Science), seven.

[2]M. Shahabuddin, et al., Biggan, (Science), eight.

[2]Doctor Muhammad Kudrat-A-Khuda, Bigganer Bichittra Kahini, (Adventures Stories of Science), (1955), Pak United Publishers, Dacca. Prescribed for classes nine and ten.

by one author who is an experienced professor of chemistry. From an analysis of the content of these textbooks it seems that most units are fairly well-developed in the textbook written by two or more authors and the textbook written by one author also contains well-developed units in the areas of his specialization. But in other areas of general science the units seem to be narrowly described. For example, in describing a unit on light in the textbook for classes nine and ten, the author assumes "ether" to be a real medium for the propagation of light energy. Furthermore, he is silent about different views related to the hypothesis. He seems to have presented a dogmatic view of the ether hypothesis which is probably no longer necessary for the interpretation of the transference of light energy.

Possibly, a distinction of the nature of scientific facts, laws, theories and hypotheses in the beginning of the unit of light, and mentioning the ether hypothesis as one viewpoint could have made the author's presentation unbiased and non-dogmatic. A knowledge of such distinction is essential for students' growth in scientific attitudes. But nowhere in the series of the science textbooks is found any such discrimination of scientific facts, laws, theories and hypotheses.

Even in the textbook written by more than one author, there are many units whose scopes are very limited. As an example, let us consider in detail a unit entitled

"Usefulness of good food" in the textbook for class six written by two authors in cooperation with one artist for drawing the diagrams of the book. The unit describes carbohydrates, fats, proteins, vitamins and water as essential components of good food. But it does not give relative percentages of the ingredients needed for a balanced diet. Also, the specific functions of the food components have not been described here. The relative percentages of the ingredients present in commonly available foodstuff, used by the East Pakistanis have not been given. Moreover, the unit does not suggest specific ways of preserving the food components.

Moreover, the unit presents an incident of cholera caused from eating infected food. But it does not state anything about how the germs of cholera spread and can be controlled. In addition, it gives yearly estimates of mortality from typhoid and dysentery without any comment on their propagation and control. How to get such information has not been indicated in the unit.

The units are not only narrow in scope but also insufficient in number. For example, there is not a single unit on tobacco throughout the series of secondary textbooks, although smoking is a common problem of the secondary school students. Similarly, cooperation among different ethnic groups is needed in East Pakistan. But, throughout

the said series, there is no mention of the human characteristics--contrasts and similarities, of the different groups. Proper understanding of these features is prerequisite for effective cooperation among the groups. Moreover, adjustment to a social group requires an understanding of the people around. Such an understanding might have been accelerated by a unit on human psychology. Such a unit has not been detected in the series of the secondary science textbooks.

Although some experiments involving independent investigation for unknown outcomes have been suggested in the textbook for classes six through eight, there is no hint for such experiments in the textbook for classes nine and ten. It therefore seems that the latter textbook does not provide a very important means for students' growth toward scientific abilities defined in an earlier chapter. In fact, all experimental description of this book are complete and logically organized without keeping room for readers' independent thinking. The students are expected to reproduce these logically organized sciences in the examination. The underlying assumption behind this practice is probably that the readers will perceive the relationships existing among the logically organized body of scientific knowledge presented in the book. And these perceived relationships will help them in transferring the knowledge acquired from reading the book.

But "The arrangement of subject matter into related sequences, plans.... do not guarantee that children will see relationships apparent to the adults who plan the program."[3] Thus, the transfer value of the logically organized science is too limited. On the other hand, according to one investigator any knowledge discovered by students' independent investigation and thinking is more transferable.[4]

Appreciation for the contributions of scientists may develop in the students when they learn along with the scientific knowledge, the hardships undergone by many scientists for the discovery of the knowledge. Throughout the series of secondary science textbooks there is very short description of only one discovery of each of the great scientists--Newton, Archimedes, Benjamin Franklin, Priestly and Lavoisier. Thus, on the average, there is only one brief story of a scientific discovery for each secondary class group to read. It seems that the historical aspects of scientific knowledge need more attention of the author of the science textbook.

However, the textbook for class eight provides a brief summary of the essential scientific knowledge at

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[3]Glenn Myers Blair, et al., Educational Psychology, (1954), p. 297.

[4]Ibid., p. 258.

the end of each chapter. Such a summary helps the retention of knowledge through relearning the contents of the chapter and so is desirable. But the other textbooks are devoid of such summaries.

It is very interesting to note that the textbooks for classes six through eight have given objective type of questions, namely, true-false, completion and multiple-choice questions at the end of the chapter to which they refer. However, the textbook for classes nine and ten contains only essaytype questions at the end of the chapters.

It is found that all the textbooks are devoid of any index for quick reference and bibliographical references for further study. As a result, the readers have to spend much more time to pick up any needful information from the text or from any related source. In functional science education collection of such information is frequently necessary. Thus, the absence of indexes and bibliography rather discourages the functional use of the textbooks.

Moreover, the readers' understanding and thinking increase through use of the supplementary references and the information of the text in solving their own problems. Thus, properly used indexes and bibliographies provide for students' growth in conceptualization and problem-solving abilities. On the other hand, a textbook without an index and a bibliography would probably encourage rote memorization for getting through the examinations.

Recommendations. So long as the existing science textbooks are not revised in the light of the suggestions to follow, the Secondary Education Board should circulate instructions for supplementing different science units by appropriate community resources and reference materials. For example, the unit, "Usefulness of good food" can be supplemented by making use of local dieticians or doctors and references collected from them. Thus cooperation between school and community experts may be encouraged and strengthened. Also, some selected books and periodicals from Appendix D should be translated and distributed as the references supplementary to the existing science textbooks.

Moreover, the unit on human body can be supplemented by a separate booklet about human reproductive organs and their normal functioning. In introducing the booklet on sex education the following procedure should be followed by the Secondary Education Board and the Textbook Board.

According to many educational psychologists, the booklet on sex education should be given a non-emotional title, such as "personal relations", "life adjustment" or "family living". Instruction on such a unit must have the whole-hearted support of parents and the rest of the community. In the beginning of such instruction at the secondary school level educational films such as "Human Reproduction" of McGraw-Hill Book Company and "Human Growth"

of the University of Oregon may be helpful.[5] Similar films can be produced by Pakistan film Services and shown to the community pressure groups for their comments. If they approve the program of sex education, the proposed unit can safely be taught in the secondary schools of East Pakistan and the said booklet should then be distributed among the students.

A textbook of general science for upper secondary classes should be written by several specialists, each one contributing the chapters in his field of specialization. Since all specialists are not experts in writing suitable textbooks in their respective field of specialization, the Textbook Board of East Pakistan should select only those specialists in different branches of general science who have proved their worth in writing scientific essays, reports, etc. and request them to write a manuscript on the curriculum. Thus the units of the textbooks can be broadened in scope and depth, and increased in number also.

In order that science education may help the secondary school students of East Pakistan adjust to their human environment, a unit on the psychology of human behavior should be added to the text of general science. To help them develop scientific attitudes, a topic on the nature of scientific research, facts, laws, theories, their interrelations and implications should be combined with an

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[5] Ibid., p. 86.

appropriate unit in the textbook for classes nine and ten.

Furthermore, all suitable units of the text should contain suggestions for independent investigations related to them. Such investigations should be graduated in order of their difficulty and should provide for individual as well as cooperative projects. Thus it seems necessary that "the textbook should describe construction of needed apparatus which can easily be prepared in the schools from free and inexpensive materials such as wood, tin, glass and wire."[6] Moreover, the science units of the text should state their major purposes.[6]

In all textbooks for secondary science classes, more historical events of scientific discovery and the painstaking research of great men of science should be incorporated in relevant units. Presentation of these historical events should make pertinent research methods, facts, laws, theories and hypotheses explicit to the readers. For example, disintegration of radium discovered by Curie will be described as a fact and Boyle's law, as a law with its limitations.

Moreover, a textbook should end its chapters with summaries of essential knowledge and key words, and should

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[6]Developed in accordance with the acceptable recommendations 8 and 9 in Appendix B.

contain a glossary of scientific terms, an index and a bibliography. Bibliographical references should be connected by a suitable convention to the science units they refer. Some of the references given in Appendixes C and D may be included in such bibliography. Also, suitable periodicals and bulletins on scientific researches in Pakistani laboratories such as that of Pakistan Atomic Energy Commision, Pakistan Industrial Development Corporation, Council of Scientific and Industrial Research should be compiled in the bibliography. Thus the secondary school students may be made more informed and more community-minded citizens of Pakistan.

Having collected the manuscript of the textbooks from the authors, they should be given to several experienced science teachers and supervisors of the secondary schools for their comments. The final drafts should be revised in accordance with their comments and suggestions, and then printed as tentative textbooks.[7] These textbooks should be tried out in several secondary schools which are representatives of the schools of East Pakistan. On the basis of the results of this "try-out" the final textbooks for all the secondary schools should be written and printed for distribution among the students.

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[7]Annoted from the recommendations of the National Society for the Study of Education, 30th Yearbook Part II, the Textbook in American Education, (1931), p. 308.

Organization of Content of the Textbooks

Organization of content adds to the meaningfulness of learning. When a student is habituated to learn in an organized way he tends to develop his own organization even when material is presented in a disorganized form. However, if he is given enrmous amount of disorganized facts his tendency to organize into meaningful relationships may be partially thwarted by the necessity of repeating them on examinations. Such learning is neither long retained nor functional.[8]

Let us assume that organization of science content should follow the method of science. The method of science starts with a perplexing situation from which a significant problem is isolated and defined clearly. By reflection one or more working hypotheses are proposed and then tested by experiments and logical analyses. An example of this method is illustrated below.

To the confusion of the tenth graders, they found ripe oranges floating, while green ones were sinking into water of a pond surrounded by mango trees. From this enigma the science teacher and the students planned together and formulated the problem-question, "What factors

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[8]Glenn Myers Blair, op. cit., p. 211.

contribute to the upward push on an immersed body?" Deliberate reflection enabled the students to propose the hypotheses--Probably density of the liquid, weight of the body, volume of the immersed portion of the body were the factors contributing to the magnitude of the upward thrust on the immersed body. If the density of the liquid was a significantly contributing factor, the magnitude of the upward thrust on a given body would be different when the same portion of the volume of the body was dipped into liquids of different densities. To test this hypothesis, they controlled the two variables--weight of the body and the portion of its volume under liquid, and allowed the density of the liquid to vary in a number of experiments.

The results of the experiments were analyzed graphically and it was found that the upward push on an immersed body is directly proportional to the density of the liquid.

Similarly, the working hypothesis--If the weight of the body is significantly contributing to the upward push, the magnitude of the upward thrust by a given liquid on the same magnitude of immersed volume of solid bodies having different weights would be different, was tested and found to be false. In testing the third working hypothesis about the volume of the body under liquid, it was found that the upward thrust on an immersed body is directly proportional to the magnitude of its volume under the liquid.

In view of the first assumption and the above illustration of scientific method, the organization of science content should consist of a specific question to be answered by experiments, critical observation and analysis. Such an organization of science unit has been identified only five times in the textbook for class six, two times in each of the books for classes seven and eight, and fourteen times in the textbook for classes nine and ten. Thus, units organized around scientific methods are few and still fewer in the textbooks for classes six through eight.

A modern trend is to organize science content around environmental things, such as, air, fire, food, etc. Such environmental units emphasize mastery of science content in natural settings. Most of the science units of the textbooks for classes six through eight are of environmental type and descriptive rather than analytic. These descriptive type of environmental units are not suitable for developing problem-solving skills and attitudes in the students.

Furthermore, the organization of science content should take into consideration the mental development of the students. This means that the scientific concepts in the textbooks for successive classes should be widened gradually. But there are many scientific concepts which are repeated in all the textbooks without being broadened

in their scope and depth. As an example, Archimedes' principle has been repeated in almost the same form in the textbooks for classes six through ten. It is regrettable to find that in the textbook for classes nine and ten, Archimedes' principle is not used for explaining depth pressure in liquids. Thus the principle has not been related to the principles of fluid pressure. Repetition of this kind without widening the concept to challenge the mental abilities of appropriate class groups is likely to kill their interest in science.

In the said textbook the units are mostly organized around major concepts of science such as electricity, light, anatomy, chemical reaction, elements, etc. Such units have the advantage of the mastery of science concepts in less time than the environmental units. However, organization of this type has less transfer value because the relationships perceived by the author of the textbook usually do not become apparent to the students and because understanding such relationships is a prerequisite for transfer of learning.

Recommendations. As mentioned in an earlier chapter of this thesis, the problem confronted by a learner increases the strength of his motives and as a result, the amount learned at a given time and the retention of learned material increase. According to a group of three science educators, science materials organized around vital problems

develops understanding of concepts and principles, problem-solving skills and attitudes over and above the mastery of content. Such unit-problem plan of organization is easily adaptable to different techniques of science teaching.[9]

Since all science materials are not suitable for unit-problem plan of organization (e.g. historical events of science), it is recommended that as many science topics as are conducive to such a plan should be organized around the major problems of adjustment for the secondary school students of East Pakistan. An example of such a plan is expalined as follows.

Unit Problem. How do communities secure a pure water supply?

Learning Problem 1.	What type of impurities are found in water?
Learning Problem 2.	Where do impurities found in water come from?
Learning Problem 3.	How are suspended impurities removed from water?
Learning Problem 4.	How are dissolved impurities removed from water? 10

From the foregoing it seems that the starting point for unit-problem organization is a problem-question which reflects the personal-social needs of the students. Also, in developing each learning problem of the unit, suggestions and procedures for related experiments should be inserted at the right place (where the experiments seem re-

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[9]Elwood D. Heiss, et al., Modern Science Teaching, (1950), p. 75.

[10]Ibid.

levant) in the context of the text. Here, some relevant questions are necessary to direct the experiment, observation and analysis of the students.[11] All the problem units are expected to cover the following types of adjustments as cores for organizing science materials.

"1. Immediate personal-social Relationships

2. Social-civic Relationships

3. Economic Relationships

4. Reflective Thinking"[12]

The preceding plan of organization seems to be appropriate for the criteria set up in chapter 2, and therefore is recommended for the textbooks of the secondary general science courses of East Pakistan. Furthermore, the organization of general science content should be guided by the following principles.

1. Content should be organized into large areas or units, each of which represents some major problem of living, area of human experience, or aspect of environment.
2. The content of any single area or unit should be broken down into smaller learning problems which have interest, significance and usefulness to the learner.
3. The learning experiences in any single problem should be organized to promote functional understandings, growth in instrumental skills, growth in processes of problem-solving and the development of attitudes, appreciations and interests.
4. Abundant opportunities should be provided both for building and applying principles and concepts.

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[11] Annoted from Carpenter & Wood's Our Environment: How We Adapt Ourselves to It, revised by Paul E. Smith, (1956), pp. 5-18.

[12] Elwood D. Heiss, op. cit., p. 74.

5. Provision should be made for effective evaluation including self-evaluation.

6. The sequence of units should be planned to give recurrent contacts with facts, concepts and principles of science and to provide a spiralling and enlarging pattern of growth in concepts and principles.

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

8. The courses in science should be organized to provide frequent opportunity for pupils to participate in planning and to engage in individual and group projects. 13

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[13] National Society for the Study of Education, The Forty-Sixth Yearbook: Science Education in American Schools, pt. 1, (1947), p. 159.

CHAPTER V

SCIENCE TEACHING AND EXAMINATIONS IN EAST PAKISTAN

In this chapter existing practices of science teaching in the secondary schools of East Pakistan have been analysed. The system of examinations adopted in East Pakistan has also been evaluated.

Teaching Practices

The success of teaching in the secondary schools of East Pakistan is usually judged by the percentage of the taught who pass the matriculation examination. Thus one of the major emphases of teaching is on the preparation of students for the examination. Usually the parents do not want to send their children to a secondary school that is not authorized by the Secondary Education Board to send its students for the matriculation examination. In granting such authorization to a new secondary school, the Board sets up certain standards to be met by the school. These standards include minimum student enrolment, faculty strengths, school equipment and the percentage of students who must pass the matriculation examination. The newly established secondary school, having achieved the

standards of enrolment, staff strengths, and equipment, concentrates heavily on preparing students for the examination. Such a concentration of the school's efforts tends to be continued indefinitely.

In spite of the school's continued efforts to prepare students for the examination, a high percentage of the candidates fail in the matriculation examination. The causes of this failure are attributed to the incompetence and negligence of the students, and the lack of teachers' attention to the academic problems of the students.[1] The students' incompetence may arise from the fact that many teachers of private schools are heavily influenced by parental pressure to promote their wards to the next higher classes.

The negligence of the students is probably due to lack of adequate motivation for studying the academic disciplines. Usually the students find cinema, newspapers, community activities, plays, etc. more interesting than the prescribed textbooks. These environmental forces of stimulation are rarely used by the secondary school teachers to motivate their students. Most teachers, being untrained pedagogically, may be unaware or unable to make use of these sources of students' motivation. They may also be unconscious of the fact that many students can do better

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[1] Chief Minister's Secretariat, Report of the Edl. Reforms Commission, East Pakistan, pt. 2, (1957), p. 39.

in the examination if they are helped individually to develop academic skills such as those of critical reading and taking lecture notes in brief outline form.

According to Mohammad Khurshed Ali's study, during the total hours of science teaching in the secondary schools 59.9% of the time was spent in lecturing, 19.6% in teacher-demonstrations, 1.7% in field trips, 17.9% in experiments, observation and analysis by students, and 0.9% in exhibition of charts and models.[2] The subjects of this study were the students from both wings of Pakistan--West and East. An interview with four science teachers from West Pakistan revealed that experimental work is required in the secondary schools of West Pakistan while for the matriculation examination in East Pakistan there is no such requirement.[3] Thus it seems that the time reported for experimentation was mainly due to the West Pakistani students included in M.K. Ali's study.

Thus the existing practices of science teaching in East Pakistan consist mainly of lectures and demonstrations planned by the science teacher to cover the materials in the prescribed science textbooks. These methods are somewhat efficient for imparting factual knowledge but

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[2] The Significance of Science in the High Schools of East Pakistan, (1958), p. 58.

[3] The question papers collected from East Pakistan Secondary Education Board support this statement.

this knowledge tends to be superficial and is not very long retained by the students. Consequently, their science education scarcely functions in later life. As an example, M. K. Ali found that the majority of the Pakistani University students he quried had serious definiencies in their knowledge of everyday science.[4]

Moreover, several studies have demonstrated that teacher and textbook dominated conventional methods of science teaching neither lessen students' superstitious beliefs nor increase their scientific attitudes and abilities.[5] On the other hand, a study of an 8-year experimental study program in thirty schools emphasized methods of problem-solving, student-teacher planning together for determining course content and methods of teaching as well improvement of these. In colleges, students of the experimental program showed their superiority over those from conventional programs in academic achievement and scientific abilities--scientific and logical thinking, intellectual curiosity and drive, self-direction and democratic values.[6] These scientific abilities probably help one in his advanced work in college science.

Recommendations. Able and interested science

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[4] Ibid., p. 68.

[5] R. Will Burnett, Teaching Science in the Secondary School, (1957), pp. 95-96.

[6] Dean Chamberlin, et al., Did They Succeed in College, (1942), pp. 176-82.

teachers should be encouraged to experiment in order to improve their methods of science teaching in the secondary schools of East Pakistan. These teachers should be helped by research experts from the teacher training colleges and universities of Pakistan, and at times by researchers from foreign universities. The results of such educational researches should be published in Pakistani periodicals in order to make them available to other science teachers who are expected to make all possible uses of the research findings in their respective schools.

Research requires time. Therefore it is recommended that the school authorities should adjust the teaching loads of a selected group of competent teachers to provide sufficient time for experimentation and verification.[7] Moreover, a science teacher of the secondary school of East Pakistan should have regular office hours during which he can discuss the problems of his students and offer necessary suggestions.

Probably, there is not one best method of science teaching but there are many methods. A teacher should consider his own previous teaching experiences as well as the background experiences of the taught before deciding on the methods he will employ. In making such decisions he

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[7]Developed in accordance with recommendation No. 16 in Appendix B. The science educators responding to the questionnaire deemed the recommendation to be desirable.

should encourage the students to express their views and suggest changes suitable for them. Thus a democratic class atmosphere can be maintained by the teacher. In any method tentatively adopted by the teacher, the purposes of teaching should be made explicit to the students. Also, the dull students should be provided more concrete and direct scientific experiences because they are likely to learn better by first-hand experiences.

Recommended Unit Method of Teaching. When scientific knowledge is presented as a part of a unit based on areas of human experience, it becomes more meaningful and more functional. In starting such a method of science teaching, the students should be given a plan of the unit to be studied and subsequent science materials should be taught as related parts of that unit. Finally, the unit activities can be summarized into a meaningful whole. An example plan of unit method is outlined below.

In order to make use of students' natural interest in environmental things, the starting point of a unit on "Fuel" for class nine may be a discussion about any related thing of the environment such as the fuel market usually reported in many newspapers of East Pakistan. During the course of a class discussion the science teacher and his students may plan together to determine the major problems, objectives and activities of the unit as indicated below.

However, the first plan should be tentative so that some related activities can be added to it as the unit develops gradually.

A. Unit-Problem. How do people secure fuel?

Learning problem 1. What are the essential components of petroleum, wood and coal?

Learning problem 2. How are fuels produced?

Learning problem 3. How can we increase our fuel production?

Learning problem 4. How can we use our fuel resources economically?

B. Major objectives. 1. To gain a knowledge and understanding of such things as :

a. The physico-chemical processes of fractional distillation, destructive distillation, oxidation and reduction, fission and fusion.

b. The meanings of boiling point, ignition point, compound element and nucleus.

c. The formation of coal and petroleum under the earth.

d. Photosynthesis and sources of solar energy.

e. The principle of conservation in the processes of transformation of matter into energy and vice versa.

f. The gas laws connecting temperature, volume and pressure.

g. Engines, dynamos and their efficiences, and power.

2. To provide opportunities for reflective and co-operative thinking and democratic group planning.

3. To develop in each student increased abilities and skills in problem-solving through experimentation, observation and analysis leading to the solution of the problem.

4. To develop in each student increased abilities to distinguish between data that are valid and those that are invalid, to collect valid information from a variety of sources, to organize the data pertinent to a problem, and to present them in front of a class group.

5. To provide each student with available opportunities for studying according to his interests, abilities, and needs.

6. To develop in each student the habits of wise use of fuels in everyday living.

7. To develop in each student social awareness of the need for fuels and consequent appreciationfor and interest in the science of fuels.

C. Activities. During class discussion and reading the textbook in the course of developing the unit on fuel, the students may find the need for taking a field trip to the nearby fuel manufacturing centers and power station, and for collecting reference materials from distant organizations such as the companies dealing with coal, oil, fuel gas and atomic fuel.

The field trip and other related activities should be planned in such a way that they have some bearing upon the problems under study. As an example, to solve the

problem, "What are the essential components of petroleum, wood and coal?" samples of different types of petroleum may be collected from a visit to an oil company. These samples can be analysed by fractional distillation. The properties of the gases liberated from each of the samples at different temperatures may be studied to identify the gases. The gases commonly present in all these samples are the essential components of petroleum. Also, destructive distillation of various samples of wood may be carried out to identify the essential components of wood. However, performing only one experiment of a series of similar ones, and reading the textbook and references for the rest of the kind may enable the students to learn the components of various fuels and their properties. Thus water gases, coal gases, isotopes of atomic fuels such as uranium, thorium, etc., can be studied from references up to the understanding levels of the students. Similarly, other learning-problems of the unit can be solved in this way.

In evaluating the unit activities, the science teacher should make sure that all the students have understood the basic concepts of the unit which are prerequisite to the study of the next unit. How to evaluate the unit activities is discussed at the end of this chapter.

An Overall Program of Evaluation

If critical thinking is required in the examinations taken by a student, he is more likely to learn to

read and think more critically. If applications of scientific principles are demanded in the examinations, he is more likely to learn possible applications of the science concepts included in the course. Similarly, he will work hard for attaining a high standard of scholarship, if passing the examinations demands such from every examinee. Indeed, the examinations, as they are now in East Pakistan, are powerful tools for motivating the students to learn the prescribed courses.

As mentioned earlier, one of the main functions of the secondary schools is to help the students pass the matriculation examination. Passing the matriculation examination of the Secondary Education Board qualifies students to enter college. After successful completion of the five years' study of the secondary education program a student is allowed to appear in the matriculation examination of the Board. If he fails the Board's examination, he is usually required to repeat one year's study of class ten in order to take the examination the following year. Such repetition involves an expenditure of money and formation of feelings of inferiority on the part of the student.

Following the practice of the Board, the promotion of a student to the next higher class of a secondary school is mainly based on the results of his yearly final

examination given by the school. Many secondary schools give half-yearly and sometimes quarterly tests to measure the academic progress of the students. But these tests are not obligatory and their results are usually not taken into consideration in promoting a student to the next higher class. Thus a student, who did not take all these tests, namely, half-yearly and quarterly tests, but has secured the highest numbers in the yearly final examination of his secondary school, is declared as the "first-boy" of the next higher class.

In the school-made tests the science teacher of the school usually sets up the questions for the science materials taught by him. In such tests, a weak science teacher is likely to set up an academic standard which is far below the generally expected norm of the age group taking the test. Thus his students gradually attain lower and lower levels of academic achievement every year. As a result, most of his students are likely to fail the matriculation examination.

In science courses, usually some objective-type tests along with essay-type tests are given in lower classes and only the latter are given in upper classes of the secondary schools. The validity of the school-made test is usually based on the judgment of an individual science teacher who has constructed the test. His estimation of the validity of the test may be questioned by the science teachers of other schools. Moreover, in the essay-

type test, there is no uniform unit for scoring the paper in quantitative measure mostly used in the East Pakistani schools. Consequently, the same science teacher is likely to use different units in scoring different examination papers. Also, different teachers use different units to estimate their students' progress in scientific knowledge.

The lack of uniform standards makes the numerical grades unreliable. In consequence, a secondary school may not depend on the grades given by another school in granting admission to a student from the latter. Moreover, a student who has successfully passed the five yearly final examinations of a secondary school but has not passed the matriculation examination is refused by any college. Thus a student is admitted into a college on the basis of his results in the matriculation examination which is a battery of achievement tests in language, social studies, mathematics and, in some cases, additional science. But an analysis of related studies made by Segel, Crawford and Burnham, Douglass and Kronenberg, and the eight-year study seems to indicate that a student's success in college depends more on his power of analysis, critical reading, and independent and reflective thinking than on the acquisition of a fund of factual information.[8]

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[8] R. Will Burnett, Teaching Science in the Secondary School, (1957), pp. 85-86.

In sending students for the matriculation examination, a secondary school gives a test of achievement in all subjects on a date about three months before the date of matriculation examination. On the basis of the test results, a certain percentage of the students is selected for taking the matriculation examination.[9] The selected students read hard during the three months before the examination. The science materials included in the examination are those prescribed in the syllabus of classes nine and ten. On these science materials a three-hour essay-type examination is given. Such an examination is not likely to cover all the materials of the syllabus but is quite likely to concentrate on a few important science materials which are often repeated every year in some form or other. To cite but one example, Archimedes' principle in different forms of language has been asked in all the matriculation examinations from 1955 to 1958. To prepare for this type of test probably encourages more factual memorization than the use of a student's power of analysis and critical reading and thinking, which are needed for advanced science study.

The matriculation examination is usually given in a town school where students from several nearby village schools come to appear for the examination. Thus most

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[9] In many private secondary schools parental influence in the form of request or threat compel the teachers to recommend some worthless students for taking the matriculation examination.

students take the examination in an unfamiliar physical environment which tends to produce fear in many students. This fear is combined with the anxiety aroused by the high percentage of failures recorded from the previous examinations. The resultant emotional tension is likely to impair the qaulity of thought of many students taking the examination.

Another difficulty more often faced by the village students is the foreign language, English, in which the examination questions must be written. Usually students of a town school become more familiar with the English language because they are acquainted with some of the English speaking people commonly found in urban areas of East Pakistan. The rural secondary schools with a few exceptions provide instruction in Bengali and prepare the tests in the language of instruction.

Recommendations. The East Pakistan Secondary Education Board should set the questions for the science examinations of the Bengali-medium secondary schools in the Bengali language.[10] To provide every secondary school with a general norm of evaluation, the Secondary Education Board, in cooperation with a few experienced science teachers of secondary schools and experts in test and measurement, should prepare yearly final tests standardized for each

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[10] This recommendation was deemed desirable by the respondents to the questionnaire study. See recommendation No. 1. d. in Appendix B.

of the classes six through ten and distribute them among the schools for administration at their own cost. The tests should aim at measuring scientific aptitudes and attitudes and achievement. The achievement test for upper secondary classes may include some essay questions with appropriate check-lists to objectify their scoring.

The science teachers of the respective secondary schools should be instructed by the Board to score the examination papers. Thus they will feel more respected and more responsible, and develop their interest in and initiative for science teaching. They will also get new ideas for improving their own test construction. However, a copy of the results of the Board's examinations should be sent to its office. On the basis of the cumulative results of the examinations from class six through ten taken by the students, the Board should select the candidates for the matriculation examination. This plan is expected to distribute students' efforts throughout the five yearly final examinations with official status, over and above the existing matriculation examination. In this way the standard of the matriculation examination can be upgraded.

However, the students who have failed in or have not been selected for the matriculation examination should be awarded a school final certificate by the Secondary Education Board. Of course, this certificate should be

based on the results of the five yearly tests of the Board. For these terminal students the respective secon-day school may issue another certificate based on internal school examinations.

In giving any test, its purposes and techniques should be made clear to the students. This can be done by the teacher's explanation of the objectives and procedures of the test. In a democratic way, the science teacher should sometimes plan together with his students for determining the purposes and procedures of the test. In order to develop intellectual honesty and critical habits, sometimes the students should be allowed to score each other's examination papers.

However, to challenge the brighter students of a given class, the school-made examinations should often include a few optional questions whose answers require careful study of outside reference materials related to the units of the textbook. Of course, certain extra marks should be allotted to those optional questions. Moreover, the diagnostic value of the school-made tests should be properly utilized for improving the efficacy of science teaching.

Furthermore, the estimation of a student's progress toward the objectives of science teaching should be based on the cumulation of results obtained from several kinds of tests. For example, a student's report on assigned observation should be graded to supplement his grades in

paper and pencil tests for the unit related to the observation. Keeping this idea in mind, the following testing procedures, which have been paraphrased from chapter 15 of the Forty-Sixth Yearbook of the National Society for the Study of Education, should be used by the science teachers of the secondary schools of East Pakistan.

Essay and objective types of paper-pencil tests can be economically used to measure students' growth in functional understanding of scientific facts, concepts and principles. These tests should be constructed in such a way that correct responses to the test-questions require reflective thinking, interpretation, criticism and application rather than mere memorization of the textual science materials. Here, description of a given demonstration, diagrams, pictures, charts, graphs, etc. can be used to provide scientific data for their identification, interpretation and analysis leading to the solution of a given problem. Thus to a certain extent, problem-solving skills and attitudes can be measured. This measurement can be supplemented by using rating scales and check lists on problem-solving skills and attitudes.

The foregoing may be supplemented by an analysis of students' work products--apparatus set-ups, notebooks, student collections, committee reports, etc. in accordance with acceptable criteria. Some criteria for evaluating apparatus set-ups are students' resourcefulness in following

instructions and performing operations according to instructions by selecting proper equipment, assembling the apparatus as a whole in the most economic order, neatness of set-up, care of apparatus and precautions against the failure of the experiments. The criteria for evaluating reports of experimental work are, clear statement of the problem, identification of experimental variables and setting up adequate controls, accuracy in observation and recording the data in organized form, interpretation of the results and consistency of the conclusion.

Daily classroom questioning and discussion can reveal much about students' growth in functional knowledge, problem-solving skills and attitudes, appreciations and interests. This procedure works only when teachers plan their questioning and discussion with an eye to evaluation. The advantage of this technique of evaluation is that students' depth of knowledge can be followed further than in the case of written tests. Probably, it is the most economic method of finding students' background knowledge as the starting point for sound instruction, and of detecting students' weaknesses for remedial teaching.

The success of functional science teaching lies in desirable changes of pupils' behavior patterns. The deliberate use of scientific concepts, principles and skills, and the spontaneous expression of attitudes, appreciations, and interests in behavior provide real evidence that the

objectives of science teaching are being realized. Of course, the observation of significant changes of behavior must be evaluated in terms of clearly defined behavioral objectives, e.g., does a student try to locate and define the major problem before planning any solution of a given problem-situation? Does he honestly consider any evidence contrary to his belief? etc.

Many classroom discussion and laboratory activities in the school, and project activities often related to community life provide opportunities for informal observation of students' behavior. Some specially planned situations, e.g., each student being asked to perform a given experiment, may be systematically observed to find changes in students' behavior. Observation must be recorded as anecdotes or in the form of check lists for analysis and evaluation.

Finally, the interview and conference with an individual can be used to supplement the written examination, especially when this latter is more or less skilled. This method, if it is to be reliable, must be conducted in a friendly and wholesome atmosphere. Then it becomes feasible to find out an individual's interests, ambitions and plans, and to guide his learning to better advantage.

CHAPTER VI

SUMMARY OF THE RECOMMENDATIONS

The recommendations that have emerged from this study are summarized in this chapter. The recommendations are arranged under the topic heading to which they related.

Recommendations for Educational Facilities and Personnel

1. The Government of East Pakistan should enforce a law to the effect that every scholarship holder must return by suitable instalments the net amount of his scholarship money when he is well-placed in worldly life. This money should be equitably distributed among the ill-equipped secondary schools to increase their facilities for science teaching. Of course, the governmental grant of money should be supplemented by a corresponding amount collected by the respective school from the local people.

2. Having secured the minimum facilities in all secondary schools general science should be made a compulsory subject for the matriculation examination of East Pakistan Secondary Education Board. Moreover, certain skills in laboratory work should be tested in the matriculation science examination.

3. The East Pakistan Secondary Education Board should sponsor a regular radio broadcast program on current science news which can be integrated with the syllabi of the five secondary classes.

4. The Pakistan Film Service in cooperation with foreign film agencies should produce teaching films for the secondary schools. Travelling film-projection equipment should be provided for those schools which do not have permanent facilities for the projection of educational films.

5. The school inspectors should take charge of distributing audio-visual materials, apparatus, reference books and professional literature by rotation among several schools which are located near one another.

6. Cooperative planning between supervisor and science teachers should always be encouraged.

7. The headmaster of a secondary school should have such professional training as to enable him to guide the science teachers of his school in improving their teaching procedures and to help them to maintain pleasant student-teacher relationships.

8. Every school should make provision for weekly faculty meetings where plans for cooperative teaching units, improvement of evaluation, classification and promotion of students can be developed and coordinated.

9. The school authorities should provide facilities for science rooms, museums, libraries and clubs.

10. A suitably large science room should be provided with moveable chairs and desks, working materials and hand tools such as saws, drills, hammer and pliers.

11. The science museum should contain students' collections with proper labels and inventory for convenience of observation.

12. Some suitable reference books and literature, as given in Appendix B, should be translated into the Bengali language for the science library of the secondary schools.

13. The science club should be provided facilities to organize educational excursions, exhibitions, special lectures and debates on science-related problems. Sometimes parents should be invited to witness the activities of the club.

14. The science teachers should have facilities to record students' aptitudes, interests, achievements, health conditions and socio-economic status for educational guidance. Optional courses in advanced physics, chemistry and biology should be offered to the science-gifted students according to their aptitudes, interests, vocational needs in classes nine and ten.

15. Teacher's training courses should be offered as optional courses, simultaneously with undergraduate science courses in suitable degree colleges. The training courses should be equivalent to one of the three science subjects required for graduation with Bachelor of Science degree.

16. The salaries of the science teachers should be on a fixed scale according to their qualifications. Moreover, the salaries of the teachers of all secondary schools should have periodic increments and pensions at the termination of a certain period of service.

Recommendations for Syllabi and Textbooks

1. The details of general science curricula for the five secondary classes should be prepared by a group of experts composed of specialists in health, agriculture and industry of East Pakistan, experienced science teachers of the secondary schools and scientists representing physics, chemistry and biology. The curricula should include those science materials which are essential for an understanding of the environment and science-related problems of East Pakistan as well as for students' growth in understanding scientific concepts and methods. As an example, much scientific information about tele-communication devices, cinema, photography, fuels, building materials, soil analysis, fertilizers and human behavior can be included in the secondary science syllabi.

2. The science syllabi should make provision for scientific interpretations of many superstitious beliefs held by the secondary school students of East Pakistan.

3. The East Pakistan Secondary Education Board should circulate instructions for remedying the deficiencies of the existing science textbooks by appropriate

community resources, and reference materials translated from the textbooks of foreign secondary schools and current periodicals, some of which are listed in Appendix B. Thus a unit on sex education should be taught after securing parental support of the representative communities of East Pakistan.

4. A new textbook of general science for a secondary class should be written by several authors, each one contributing the chapters in the areas of his specialization.

5. The new textbook should contain suggestions for independent scientific investigations up to the understanding levels of the students and description of the construction of needed apparatus which can be prepared in the schools from free and inexpensive materials.

6. Pertinent historical events and researches of great scientists should be included in the appropriate places of the new textbook. Presentation of historical science should be such as to enable the students to differentiate between scientific methods, facts, laws, theories and hypotheses.

7. The new textbook should contain a summary of the scientific knowledge and key words of each chapter at its end.

8. The new textbook should contain a glossary of scientific terms, an index and a bibliography keyed to the units of the text by suitable conventions.

9. In the new textbook suitable science materials should be organized as units representing major problems of "personal-social relationships", "social-civic relationships", and "economic relationships". The organization of a unit should present one or more elements of scientific method. Moreover, a large problem of the unit should be split into smaller learning problems which are meaningful, interesting and useful to the students of the secondary schools of East Pakistan. These learning problems should provide frequent opportunities for building and applying concepts and principles through individual and group planning, and project activities.

10. The sequence of the units of the new textbook should be so planned as to provide recurrent contacts with facts, concepts and principles of science for students' growth in functional understandings, problem-solving skills and attitudes, interests and appreciations.

11. The units of the new textbook should provide hints for evaluation, including self-evaluation.

12. The manuscript of the new textbooks should be given to the science teachers and supervisors of the representative secondary schools of East Pakistan for their comments. In the light of their comments the draft should be revised and printed as a tentative textbook which is to be given a trial in the representative schools. On the basis of the results of this "try-out" the science textbook should be written and printed for use.

Recommendations for Teaching and Evaluation

1. Interested and competent science teachers should be provided enough facilities for experimentation to improve science teaching in the secondary schools of East Pakistan. The science teachers should be guided and helped by research experts from the universities of Pakistan and abroad. The results of these educational researches should be published in periodicals and bulletins in order to make them available to other science teachers.

2. To make use of students' interests in environmental things and activities, science materials should be taught as problem-units organized around relevant things and activities of natural interest to the students of the secondary schools of East Pakistan.

3. The East Pakistan Secondary Education Board should set the questions for science examinations of the Bengali-medium secondary schools in the Bengali language. In cooperation with some experienced science teachers and experts in tests and measurement, the Board should prepare tests of scientific aptitudes, attitudes and achievement standardized for each of the five secondary classes. On the basis of the cumulative results of these tests having been administered and scored by the science teachers of the respective secondary schools, the Board should select the candidates for the matriculation examination. Those students who fail in or are not selected for the matriculation examination should be awarded school final certificates, based on the results of the five yearly

tests, by the Board.

4. The school-made tests in science should include essay and objective types of tests, rating scales and check lists, analysis of students' reports, collections, note-books, apparatus set-ups, etc. according to acceptable criteria, classroom questioning and discussion, anecdotal records of students' behavior, and interview and conference with students.

Finally, the foregoing should demand reflective thinking, criticism, interpretation and applications of science materials from the students. Every attempt should be made to utilize the diagnostic value of the tests for the efficacy of science teaching.

APPENDIX A

QUESTIONNAIRE SUBMITTED TO FIFTEEN EAST PAKISTANI SCIENCE EDUCATORS

Direction:

Each item below is a tentative suggestion for the improvement of science education in the secondary schools of East Pakistan. Please check ( ) in the appropriate place on the line below each item to indicate your view on that item. If you disagree with a suggestion, please write your views on the space below the line. Even if you have no opinion for a certain item, please try to indicate on which side of the no opinion line you are even slightly inclined. For example, "commercial demonstration equipment is superior to homemade demonstration equipment in helping students to learn science." If a person ismore or less neutral on this issue, but slightly prefers commercial equipment, he might check the line as follows:

/	/	/V	/	/
Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

Your name: -

Your title or other designation: -

1. a. "Some system of student selection by examination should be introduced at the beginning of secondary school, that is, class VI."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

b. "To select students for class IX, a province-wide examination should be introduced at the end of class VIII."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

c. "A suitable intelligence test should supplement the examination for the selection of secondary students."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Fully Agree

d. "Since Bengali is the medium of instruction in secondary schools, it is justifiable to set the questions for the matriculation science examination in the Bengali language."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

2. "Practical work such as the preparation of simple apparatus, models for science projects and laboratory experiments should be compulsory in secondary school science courses."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

3. "Needed but expensive apparatus should be used by rotation among several schools which are located near to each other."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

4. a. "Some inexpensive audio-visual materials should be used by science teachers in the teaching of science classes."

Totally Disagre	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

b. "Science news appropriate for secondary school students should be broadcast regularly on the radio."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

5. "To study science-related problems of East Pakistan, students from rural schools should occasionally take educational excursions to urban areas and vice versa."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

6. "Every school should provide facilities for organizing students' science associations. The functions of such associations should be to organize educational excursions, exhibitions, special lectures and debates on

science topics as well as subscribing to and sometimes publishing science magazines."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

7. "To develop interest in science every school should help students to build their own science museum where science-materials collected and prepared by them can be kept and observed."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

8. "Every science textbook is supposed to serve some purposes of science education. These purposes should be clearly stated and explained in the text."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

9. "Science text books should describe construction of needed apparatus which can easily be prepared in the schools from free and inexpensive materials such as wood, tin, glass and wire."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

10. "The Education Directorate should supply every school library with sufficient copies of the Bengali translation of at least three different science textbooks of the

secondary schools of scientifically advanced countries. These translated books should be used as references to increase the students' understandings of the prescribed science textbooks."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

11. "A suitable course of psychology should be introduced in the secondary science syllabus. This course should help students to understand human behavior and the learning process."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

12. a. "To develop scientific thinking in the students, methods of scientific research and inquiry should be inculcated in the teaching of the secondary science courses. These methods include systematic observation, drawing conclusions, making inferences and hypotheses from observed data."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

b. "A concise history of the development and methods of scientific research should be introduced in the secondary final year. This should provide each student with wide information about science in order to facilitate his choosing the most suitable branch of science for his college study."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

13. "To increase the number of trained science teachers, teacher's training courses should be offered, as optional subjects, simultaneously with undergraduate science courses in suitable degree college."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

14. "A pleasant relationship between a teacher and his students is needed for effective teaching. The headmaster should advise and help his science teachers to maintain pleasant student-teacher relationships."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

15. "In every year, inventions in every-day science and for improving science teaching are coming out of researches in many advanced countries of the world. The Education Directorate should make these research results available to the secondary schools."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

16. "The teaching load of a science teacher should be so adjusted as to provide him with sufficient time to consult recent research findings and prepare corresponding demonstrations for teaching his classes."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

17. "In every school there should be regular weekly meetings of teachers. In these meetings junior science teachers should freely discuss their teaching problems with senior teachers of any subject."

Totally Disagree	Disagree More than agree	No Opinion	Agree More than disagree	Agree Fully

APPENDIX B

REACTIONS OF FIFTEEN EAST PAKISTANI SCIENCE EDUCATORS

Recommendations as stated in the questionnaire	Frequency		Levels of statistical significance on 50-50 probability by chance
	Agree	Disagree	
1. a. "some system of student selection by examination should be introduced at the beginning of secondary school, that is, class VI."	10	5	
b. "To select students for class IX, a province-wide examination should be introduced at the end of class VIII."	8	6	
c. "A suitable intelligence test should supplement the examination for the selection of secondary students."	9	6	
d. "Since Bengali is the medium of instruction in secondary schools, it is justifiable to set the questions for the matriculation science examination in the Bengali language."	15	0	0.01
2. "Practical work such as the preparation of simple apparatus, models for science projects and laboratory experiments should be compulsory in secondary school science courses."	15	0	0.01
3. "Needed but expensive apparatus should be used by rotation among several schools which are located near to each other."	13	1	0.01
4. a. "Some inexpensive a-v materials should be used by science teachers in the teaching of science classes."	14	1	0.01

Recommendations as stated in the questionnaire	Frequency		Levels of statistical significance on 50-50 probability by chance
	Agree	Disagree	
4. b. "Science news appropriate for secondary school students should be broadcast regularly on the radio."	14	1	0.01
5. "To study science-related problems of East Pakistan, students from rural schools should occasionally take educational excursions to urban areas and vice versa."	15	0	0.01
6. "Every school should provide facilities for organizing students' science associations. The functions of such associations should be to organize educational excursions, exhibitions, special lectures and debates on science topics as well as subscribing to and sometimes publishing science magazines."	15	0	0.01
7. "To develop interest in science every school should help students to build their own science museum where science materials collected and prepared by them can be kept and observed."	15	0	0.01
8. "Every science textbook is supposed to serve some purposes of education. These purposes should be clearly stated and explained in the text."	14	1	0.01
9. "Science textbooks should describe construction of needed apparatus which can easily be prepared in the schools from free and inexpensive materials such as wood, tin, glass and wire."	15	0	0.01
10. "The Education Directorate should supply every school library with sufficient copies of the Bengali translation of at least three different science textbooks of the secondary schools of scientifically advanced countries. These translated books should be used as references to increase the students'			

Recommendations as stated in the questionnaire	Frequency		Levels of statistical significance on 50-50 probability by chance
	Agree	Disagree	
understanding of the prescribed science textbooks."	14	1	0.01
11. "A suitable course of psychology should be introduced in the science syllabus. This course should help students to understand human behavior and the learning process."	9	5	
12. a. "To develop scientific thinking in the students, methods of scientific research and inquiry should be inculcated in the teaching of the secondary science courses. These methods include systematic observation, drawing conclusions, making inferences and hypotheses from observed data."	11	3	
b. "A concise history of the development and methods of scientific research should be introduced in the secondary final year. This should provide each student with wide information about science in order to facilitate his choosing the most suitable branch of science for his college study."	9	4	
13. "To increase the number of trained science teachers, teacher's training courses should be offered, as optional subjects, simultaneously with undergraduate science courses in suitable degree colleges."	14	1	0.01
14. "A pleasant relationship between a teacher and his students is needed for effective teaching. The headmaster should advise and help his science teachers to maintain pleasant student-teacher relationships."	15	0	0.01

Recommendations as stated in the questionnaire	Frequency		Levels of statistical significance on 50-50 probability by chance
	Agree	Disagree	
15. "In every year, inventions in every-day science and for improving science teaching are coming out of researches in many advanced countries of the world. The Education Directorate should make these research results available to the secondary schools."	14	1	0.01
16. "The teaching load of a science teacher should be so adjusted as to provide him with sufficient time to consult recent research findings and prepare corresponding demonstrations for teaching his classes."	14	1	0.01
17. "In every school there should be regular weekly meeting of teachers. In these meetings junior science teachers should freely discuss their teaching problems with senior teachers of any subject."	15	0	0.01

Here significance at the 0.01 level means that the probability of obtaining an equally extreme departure from a 50-50 split through chance sampling factors is only 1 in 100 or 1%.

APPENDIX C

REFERENCE BOOKS SUGGESTED FOR THE SCIENCE TEACHERS OF EAST PAKISTAN

1. Hutchinson's Technical and Scientific Encyclopaedia. 4 vols., The Macmillan Company, New York.
2. Physics Handbook. Issued by Bureau of Secondary Curriculum Development. The New York State Education Department, Albany, 1956.
3. Research: Science and Its Application in Industry, Butterworths Scientific Publications, London, 1955 and onward.
4. Review of Educational Research. National Education Association of the United States, Washington, D.C., 1950 and onward.
5. School Science and Mathematics, 535 Kendall Avenue, Kalamazoo, Michigan, 1950 and onward.
6. Science Education, Science Education, Inc., 525 West 120 Street, New York City, 1950 and onward.
7. The General Science Handbook. 3 pts., Issued by Bureau of Secondary Curriculum Development. New York State Education Department, New York, 1952.
8. The Research Quarterly of the American Association for Health and Physical Education, 311 Maynard, Ann Arbor, Michigan, 1940 and onward.
9. UNESCO Source Book for Science Teaching. Issued by UNESCO, 19 avenue Kleber, Paris 16e, 1956.
10. Van Notrand's Scientific Encyclopaedia. D. Van Nostrand Company Inc., New York, 1947.

APPENDIX D

REFERENCE BOOKS SUGGESTED FOR THE STUDENTS OF EAST PAKISTAN

1. Ahrens, Maurice R., et al., Living Chemistry. Ginn and Company, Boston, 1942.

2. Bayles, Ernest E. and R. Will Burnett, Biology for Better Living. Silver Burdett Company, New York, 1946.

3. Efron, Alexander, Basic Physics, I. John F. Rider Publisher, Inc., 116 w. 14th st., New York 11, N.Y.

4. Harrison, J.M., Elementary General Science. 3 vols., Longman, Green and Co., London, 1952.

5. Science, A weekly Periodical of American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington 5, D.C., 1955 and onward.

6. Science News Letter, The Weekly Summary of Current Science, A Science Service Publication, 1719 N st., N.W., Washington 6, D.C., 1950 and onward.

7. Wood, George Clayton and Carpenter. Our Environment, How We Adapt Ourselves to It, rev. Paul E. Smith. Allyn and Bacon, Inc., Boston, 1956.

8. _____, Our Environment, How We Use and Control it, rev. Gordon E. Van Hooft. Allyn and Bacon, Inc., Boston, 1956.

9. _____, Our Environment, Its Relation to Us, rev. Paul E. Smith. Allyn and Bacon, Inc., Boston, 1956.

APPENDIX E

A LIST OF FILM AGENCIES PRODUCING EDUCATIONAL FILMS

1. Almanac Films, Inc., 516 Fifth Ave., New York 36, N.Y.
2. Association Films, Inc., 347 Madison Avenue, New York 17, N.Y.
3. Balley Films, Inc., 6509 De Longpre Avenue, Hollywood 28, California.
4. Council Films Inc., 50 North Main Street, Homer, N.Y.
5. Educational Film Library, Syracuse University, Bldg. D. 7, Collendate Campus, Colvin Lane, Syracuse 10, New York.
6. Encyclopeadia Britannica Films, Inc., 1150 Wilmette Ave., Wilmette, Illinois.
7. Film Library, State College, Pocatello, Idaho.
8. G.B. Equipments Ltd., Film Division 1, Aintree Road, Perivale, Greenford, Middlesex, England.
9. Pix Film Service, 34 East Putnam Avenue, Greenwich, Connecticut.
10. United World Films, Inc., 1445 Park Avenue, New York 29, N.Y.

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Ikram, S.M. and Percival Spear, ed., The Cultural Heritage of Pakistan. Oxford University Press, Karachi, 1955.

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McGeoch, John A., The Psychology of Human Learning: An Introduction. Longmans, Green and Co., New York, 1942.

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