

## SCIENCE SYLLABI WITH ENVIRONMENTAL EMPHASIS IN THE CARIBBEAN

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### Introduction

Over the last two decades, the Caribbean, in common with the rest of the world, has become increasingly aware of environmental issues. These have surfaced not only in the professional conscience, but in the political consciousness as the small island nations of the region struggle to throw off the label "developing", and improve the quality of life for their peoples.

Small tropical island ecosystems tend to be extremely fragile, with limited resources. The effects of short-sighted unplanned development, some of them irreversible, do not require a very long time to become obvious. Awareness of issues and the problems accompanying them is, however, not enough. If nations are to be successful in arriving at the delicate balance between using and preserving the environment which is necessary for sustainable development, the population must be committed to this approach. Such commitment can only come with some knowledge and understanding of the processes and forces at work in the total environment, and a willingness to recognize man's responsibility to plan "in tune with nature".

Knowledge, understanding and attitude change mean education - in both the formal and non-formal systems. Several organisations in the various territories have been involved in trying to work environmental concepts and themes into schools, and public lecture/display type programmes in both formal and non-formal systems. These include, for example:-

Science Teachers' Associations: The Association of Science Teachers of Jamaica (ASTJ), the Association for Science Education of Trinidad and Tobago (ASETT). Both run courses and science exhibitions/fairs which encourage environmental themes.

Civic and professional groups: The Caribbean Conservation Association, the Belize Audubon Society, the Young Scientists' Movement of Grenada, the Natural History Society and the Jamaica Society of Scientists and Technologists, both of Jamaica, the Society for the Conservation and Preservation of the Environment of Trinidad are all involved in activities which aim at increasing environmental awareness in the society.

Government Ministries and Departments: The Ministries of Education, Health, Environment, Mining/Natural Resources, Agriculture in all territories are concerned in one way or another in promoting formal school programmes and/or non-formal instruction in matters dealing with the environment.

The formal system represents the largest 'captive' audience, and it is the secondary level of this system that this article will address.

Injecting material into existing curricula/courses, must follow one of two patterns. Either those teaching the material, out of commitment, interest and knowledge, must 'push it in' from the 'bottom up', or the educational system must be directed in such a way as to do this 'from the top down'.

In the Caribbean, two factors contribute to the fact that the second method is the one more likely to succeed at this. Firstly, the teaching staff is neither of the magnitude nor of the trained competence desirable throughout the entire region.

Secondly, in the English-speaking Caribbean, three hundred years of British rule, has meant an educational system built up around the British model. This system, and the thinking of the society as a whole are very largely influenced by the philosophy of dependence on externally set public examinations. These dictate what is taught in all educational institutions, with the probable exception of the University of the West Indies, which, of course, sets its own examinations.

The single instrument, therefore, that is likely to be most successful in integrating an environmental dimension into secondary curricula in the region is the Caribbean Examinations Council (CXC). This is the relatively new body which is gradually replacing in the Caribbean the English examining bodies which organized public examinations at the grade eleven (fifth form: 16-17 year group) level.

All of the panels which have designed the CXC science syllabi have regarded science as an important route for encouraging students to be intensely aware of the Caribbean environment and care for it.

The subjects concerned are biology, chemistry, physics, integrated science (double award<sup>1</sup>) all offered at general

<sup>1</sup> Double award here signifies that the syllabus, because of its wide content coverage, has a weighting equivalent to two CXC subjects at General Proficiency, it is so certified.

proficiency, and integrated science (single award - general and basic proficiency<sup>2</sup>). The syllabi for all these subjects have made statements which declare their commitment to the task of educating, not just about, but for the environment, as Fensham and Hunwick (1983) put it. For example, in the Physics Syllabus, it is stated that one of the general aims is to help candidates to :-

*develop an awareness of an application of scientific knowledge and a concern about the consequences of such application.*

(p. 2)

The Integrated Science (Single Award) Syllabus lists as two of its aims that students should display 'respect for life and property' and 'appreciation of the necessity to use wisely the resources of the environment'. (p. 1)

All of these syllabi were released for general use in 1983, the first examinations took place in June 1985. Therefore, this is happening now. (One syllabus, the Integrated Science (Double Award), has, however, been examined as a pilot project for some years).

The paper proposes to analyse the Biology, Chemistry and Integrated Science (Double Award) Syllabi, to see how each has gone about the task of integrating environmental concerns into its requirements. This integration is reflected both in the arrangement of the syllabus content, and in the style of evaluation. The latter is structured, not just to indicate candidates' total achievement, but their performance along certain profiles. In these science syllabi, the profiles basically reflect candidates' knowledge in the subject area, their ability to use that knowledge, and selected attitudes which are an expression of environmental concern.

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<sup>2</sup>CXC offers two (2) types of examinations - Basic Proficiency and General Proficiency ... The Basic Proficiency examinations are aimed primarily at the world of work. They are useful for subjects in which candidates do not expect to pursue further study ... The General Proficiency examinations are designed to provide a base for further work in a particular subject area. The syllabi are, therefore, more demanding in terms of depth of coverage. (Source: 'CXC and the Employer', Caribbean Examinations Council, November 1983).

## THE SYLLABI

### Content

#### Biology

The biology panel, because of the nature of the subject, saw itself in a specially intimate position with regard to the environment. In the given rationale for its study, the syllabus states that :-

*Biology, by its very nature, is of immediate relevance to every individual since it deals with life processes, the knowledge and understanding of which can serve to improve, at a very personal level, the quality of man's life: This understanding should generate a concern for all living things and an attitude of responsibility for the care of the total environment which supports life . (p 1)*

In the suggestions given for teaching the syllabus, it is stated that among the over-arching emphases which teachers should try to promote are:

1. *Every opportunity should be taken to relate biological studies to the environment, and to use an ecological approach wherever pertinent. Biological principles should be illustrated by local/regional examples ...*
2. *In order to make the course as relevant as possible, students' awareness of the effect of science on society and vice versa should be fostered. In other words, the environment is to be interpreted in its totality, as including all the social aspects, as well as the biological and physical. (p 3)*

The syllabus is divided into five sections, of which the first and last address environmental concerns most directly. They are named 'Living Organisms in the Environment' and 'The Environment and Man'. In the other sections, which cover 'Life Processes', 'Continuity and Variation', and 'Disease and Man', the stress though more indirect, is still there as is indicated in the rationale and suggested emphases. Although no prescriptions are laid down for a teaching order, teachers are advised to begin with the section on 'Living

Organisms in the Environment'. The intent is, from the very introduction to the syllabus, to make the point that an environmental slant is being encouraged throughout.

#### SECTION A: Living Organisms in the Environment

No great depth of treatment is expected in this introduction, but the general objectives express the environmental direction. These state that students should demonstrate an understanding that :-

- *there is both diversity and similarity of form in living organisms*
- *there is interdependence between living organisms and their environment*
- *there is a flow of energy through living organisms within an ecosystem*
- *substances are recycled in nature.*

(p. 13)

#### SECTION E: The Environment and Man

This section is intended to fill out the work introduced in Section A in order to 'lead students to a fuller appreciation of the variety and complexity of the inter-relationships between organisms and their environment'. It also stresses that 'man is a part of his environment and must, therefore, show a sense of responsibility for its maintenance and improvement'. The general objectives for this section state that students should demonstrate:-

- *some understanding of the importance of the soil to living organisms*
- *an ability to carry out an ecological study*
- *an understanding of the effects of man's activities on the environment and an appreciation of the finite nature of the world's resources.*

(p. 31)

The purpose of the section on Disease and Man is 'to make students sufficiently aware of the problems and their implications so that they can recognize and deal with them in their own environments'. (p 28). Diseases dealt with are those specifically affecting the quality of life, efficiency of the human resources and economy of the region. Students are required, among other things, to 'discuss the social and economic implications of disease' (p 30) - part of the stress on the environment in its totality, including the social.

The section on Continuity and Variation highlights the implications of variations within and between species, and gives room for a consideration of how man uses his knowledge of the consequences of meiosis, for example, in agriculture - in the local situation, as in the breeding of bananas, sugar cane, cattle.

Section B deals with Life Processes; principles and processes are illustrated by local examples throughout.

### Chemistry

Among the stated aims of the chemistry syllabus, are the following: The syllabus is designed to help students to :-

- be aware of the power, impact and influence which chemistry has in a modern scientific world and emphasize that there is a responsibility that chemistry be used for the good of the society
- appreciate and understand how chemistry enables materials to be used in the service of mankind, in the Caribbean and elsewhere.

(p 1)

The above makes it clear that environmental concerns are a definite feature of this syllabus. As with the biology syllabus, there is a concentration in a specific section on these concerns. Section C deals with Chemistry in Industry; students must select one local industry for in-depth study. This is the current aspect of a wider concern for chemistry in society being explored at this time: the intention is to select other aspects from time to time for special study.

Among the general objectives given for this section of the syllabus, are that students should :-

- demonstrate the way in which the concepts and principles of chemistry are used to solve problems in everyday life.
- demonstrate the spirit of enquiry, making possible the continuing search for new ways of using materials in the service of mankind.
- develop an awareness of the scope and potential of chemistry in both developed and developing countries
- appreciate the power, impact and influence which chemistry has in the world and emphasize the responsibility to use chemistry only for the good of the society.

(p 30)

The details expected include a consideration of the raw materials, principles underlying chosen processes, the economic of production, the generation of waste products, the possibilities for recycling and effects of the industry on the environment, including the social changes which may result because of the presence of the industry. (p 33)

This is not to say that reference to the environment has been neglected in other sections. For example, in Section A, Units 1-5, 6, 7, require students to identify major energy sources, and discuss alternatives with special emphasis on those which would be practical in the Caribbean (p 9). Section B2, Units 2-6, 7, 9, include a consideration of the importance of the recycling of materials in nature, and the consequences of the solvent properties of water including pollution (p 27). Throughout the entire material, as well, local examples are used to illustrate principles wherever possible.

#### Integrated Science (Double Award)

This syllabus is built on the rationale that "it helps the student to look at a field of study not only from within but from the viewpoint of the links between the various branches" Its concerns, therefore, include both those of the biology and chemistry syllabi, and as well, it is able to tap other areas of science in a single syllabus.

Among its aims are that students should develop:-

- *respect for life and property*
- *understanding of the significance and limitations of science in relation to social and economic development*
- *an awareness of, and concern for, the application of scientific knowledge.*

(p 3)

In pursuance of the establishment of the links between the branches of science as expressed in the rationale, the syllabus lists several integrating threads which run throughout. Among these are that candidates should demonstrate:-

- *an awareness that different forms of energy are interconvertible and that energy flows from the sun are needed for the formation of fuels and the photosynthetic process which is essential for life on this planet.*
- *an awareness that the earth's resources are wasting assets and hence there is a need to:-*

- (i) use wisely existing resources
  - (ii) in the case of energy resources, search for alternative sources of energy
  - (iii) actively strive for the maintenance and preservation of life
- an understanding that there is interdependence between the organism and its environment.

(p 10)

The arrangement of the syllabus is also in sections with Section B: Our Environment and its Resources and Section D: Life and the Environment exclusively devoted to environmental concerns.

#### SECTION B: Our Environment and its Resources

In this section, the physical environment, its effect on life and man's use of it, are dealt with. Among the general objectives listed are that candidates should demonstrate:-

- an understanding of the mode of formation, composition and distribution of the various components of the earth's crust, core and mantle
- an understanding of the role of the atmosphere in influencing life on earth
- an understanding of the various activities in the earth and its atmosphere which give rise to natural disasters, and the areas in which these activities are most likely to occur
- an awareness of the implications of the limited nature and uneven distribution of many of our natural resources
- an ability to evaluate the implications of man's exploration of his environment
- an understanding that the soil is a complex and dynamic system which is supportive of life on this planet.

(p 23)

#### SECTION D: Life and the Environment

As is stated in the preamble to this section, 'it is expected that an understanding of the structure and behaviour of organisms, their relationships with each other and with the rest of their environment will assist the student in making reasonable judgements about man's interaction with his own environment. This understanding should be part of the background needed for making intelligent decisions about many of the social issues facing the modern world'. (p 45)



The subsection which is most concerned with the 'relationships' aspects is D(III) which gives among its general objectives, that candidates should demonstrate:-

- an ability to use some of the techniques of sampling organisms and investigating their relationships with various environmental factors
- an understanding that plants and animals form part of the natural resources which are directly useful to man
- an ability to evaluate the social implications of technological developments, e.g. genetic engineering, birth control, organ transplant, food technology.

(p 46)

The energy concerns quoted in the list of integrating threads above, are dealt with in an earlier section (C) (p 32).

Thus, in these syllabi, the attempt has been made, albeit in various ways, to focus the attention of Caribbean children on the :-

- need to respect all life and property
- interdependence of things in nature
- finite nature of the world's resources
- responsibility of science for service to mankind and the limitations of technology for promoting social and economic development
- environment in its totality.

Further, the insistence on the use of local examples for illustration as far as possible, should bring the content within the children's real life experience.

### Evaluation Strategies

The claim for the Caribbean Examinations Council (CXC) is not that other examining bodies used in the region in the subject areas have not embodied environmental content in their syllabus since the Chemistry Syllabus of the General Certificate of Education of the Cambridge Examination Syndicate (Ordinary level) gives as one of its aims 'to show how the activities of chemists have social, industrial and economic consequences for the community'. Further, in its introduction to the syllabus, it states that 'it is also hoped that teachers will be able to relate the factual content of the syllabus to social, economic and industrial life both on a national scale and on a local scale as appropriate.'

Ecology, for example, has always been a part of the content of the biology syllabus, but in the Caribbean, was largely neglected in the teaching because students could omit it and still do well in the examinations.

In contrast, the claim for CXC is that, there is the definite intent built into the system, that students must be exposed to the environmental experiences suggested within the syllabi, if they are to perform creditably in the examinations.

Two modalities are used for evaluation, viz. written and/or practical terminal examinations, and a form of continuous assessment termed School Based Assessment. Both modalities reflect the environmental emphasis.

### The Terminal Examinations

The fact that all the syllabi are divided into sections, makes it easier to so control the design of the written papers that successfully performing students must cover the environmental sections. The attempt is made, as far as possible, to spread questions evenly across all sections of the syllabus in a carefully designed format. There are the usual objective type questions and compulsory structured questions. There is also an essay paper which though not completely compulsory, does not carry an entirely open choice situation. Questions are arranged in pairs, which are chosen according to sections of the syllabus. Students are required to answer one from each pair, in a way that they cannot evade entirely the environmental concerns if they complete their papers.

Written questions may also be designed to tap not only factual knowledge of environmental matters, but attitudes as well. In the case of biology, this attitude has been termed 'environmental awareness', and defined as 'showing due care and concern for the preservation of the environment and an appreciation of the human ecological approach to its development.' (p 4). In the integrated science and chemistry syllabi, the term 'social awareness' is used. This has been defined in the chemistry syllabus as covering 'conservation of resources' safety and concern for the environment.' (p 5) The biology and chemistry syllabi were examined for the first time in 1985. In Appendix I are given three examples which serve to indicate the thinking on how questions may be structured to evoke attitude responses. The first two questions are drawn from past papers in integrated science (double award); the third is taken from the biology specimen paper.

## School Based Assessment

School Based Assessment (SBA) has been designed to look, over a five term period, at students' practical work. The assessment takes into consideration practical skills, some enquiry skills (usually interpretation), and some attitude component.

School Based Assessment carries a heavy environmental dimension. In all three subjects the assessment of practical skills in an ecological context is expected. In chemistry and biology, 'social' and 'environmental' awareness as defined above are also included in SBA.

Thus the evaluation strategies used by CXC make it absolutely essential for teachers to include environmental aspects in a way that is very relevant to the student. This is the force which it is hoped will give the desired direction to 'push' from the 'top down'. Will it have the desired effect? Of necessity, it warrants a change in instructional approaches and techniques, in the way familiar content is organized and presented. One, therefore, has to remember two basic maxims pertaining to the teaching/learning situations. The first is that an essential adjunct to any syllabus innovation is teacher training. Syllabus intentions cannot be fulfilled without the understanding, competence, co-operation and commitment of teachers. In matters dealing with the environment, where one seeks to remould and build attitudes, teacher training assumes even more importance.

The second is that unless learning has taken place, neither has teaching. Even if one assumes that satisfactory teacher training has been effected, how far can one expect that the emphases stressed in the syllabi will be realized in the learner? The syllabi have been in use for a very short time: it will take many years to assess their impact. One can, however, in the light of experience, have certain expectations. Even with training, there will be a measure of "teacher resistance" since different paths must be trod. Students in these situations are less likely to understand the spirit of the syllabi. On the other hand, in all of the syllabi looked at, SBA contributes at least 20 percent to the evaluation of student performance. This direct participation in the examination process should not only provide a positive stimulus for the teacher, but motivate the students who are aware that their efforts over the entire two year period will be taken into account. In this latter situation, one expects an environment which promotes understanding and learning. Additionally, since the written terminal examinations attempt to support the practical and environmental emphases of SBA, it is hoped that continued improved student performance will

further motivate succeeding generations of students. In this way, with time, desirable environmental attitudes should be strengthened in the society. Indeed, the writer is of the opinion that in the Caribbean where success in public examinations is, with some justification, regarded as the 'open sesame' to the individual's progress, this is a tool which can cogently and deliberately be used to promote the aims of environmental education, and encourage the caring attitude for the environment which has become so important and necessary in the world today. The very civic minded societies, and government organizations and laws, have done little to halt the march of often wanton destruction. The attitude of the up-coming generation must be changed.

The Caribbean Examinations Council, with its emphasis on regional relevance, is in an excellent position to help to encourage this. A concerted effort through its offerings, such as is reflected in the science syllabi described, and which, in one form or another will reach the entire secondary school population of the region in a very few years, should, in good measure, be able to promote this better understanding and sense of responsibility for the environment which is desirable.

If and when some comprehensive evaluation of these syllabi is made, two vital foci should be how well they have served the regional interest in helping to promote environmental improvement, and the degree to which they have heightened awareness to, and appreciation of, other scientific issues, in the students who have been exposed to them.

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## APPENDIX I

### Samples of Examination Questions Intended to Evoke Attitudinal Responses

#### From Integrated Science (Double Award) Past Papers

1. As the human population of the earth increases, we can expect an increase in the amount of heat generated by man's activities. The heat is radiated from the earth's surface as infrared radiation but unfortunately this type of radiation does not pass easily through the atmosphere to outer space. The blanketing effect of the atmosphere is increased by a rise in the level of carbon dioxide and this itself is expected to increase as mankind multiplies.

(a) Outline the problems that might face the earth's inhabitants in the future as a result of these changes in the atmosphere, should they occur.

(b) To reduce the problems, what can be done by

- (i) individuals
- (ii) governments
- (iii) international organisations?

(Knowledge, 1; Enquiry Skills  
12; Attitudes 2 marks)

Evidence of 'Social Awareness' would be reflected largely in candidates' answers to part (b). Expectations were that attitude components might include, for example:

- (i) Objectivity - seeking and weighing evidence
  - using evidence to make judicious decisions
  - considering consequences of one's actions

(ii) Concern for the preservation of the integrity of the earth as a life sustaining planet

(iii) Appreciation of the limitations of technological advancement.

2. A recent development in genetic engineering to attract attention in the press was the successful transplant of a rabbit gene into monkey cells by Berg, Mulligan and Howard at Stanford University. Commenting on this achievement, one scientist stated that it should be

possible to develop the technique so that it could be used to replace defective or missing genes, to suppress the expression of genes which are harmful and to introduce genes into animals and plants which would make them better suited to serve mankind.

Consider a large group of enthusiastic scientists experimenting in this way with gene transplantation.

- (a) Carefully describe two specific dangers from these experiments which they should bear in mind.
- (b) What should the scientists do to minimize the risks arising from the breeding of new strains of animals and plants?

(Knowledge 5 marks, Enquiry skills 9 marks,  
Attitude 2 marks)

Expectations for this question were that the candidate's answer would reflect a balanced view of the problem. To be awarded the marks for attitudes, he/she must have indicated both an appreciation of man's attempt to improve the quality of life, and the need for caution in the use of such technology, since it might endanger the life of various organisms (including man) directly or indirectly, thereby upsetting the balance of nature. Alternatively, the candidate's answer might have reflected a certain value, as well as some caution and scepticism, in his/her approach to scientific investigations.

From Biology Specimen Paper

3. (a) Illustrate and comment on the pattern of growth of a population assuming that food is the only limiting factor.  
(6 marks)
- (b) What other factors may affect the growth rate of a population?  
(3 marks)
- (c) "As the highest group of organisms in the animal kingdom, man must control the growth of his own population".

Do you agree with this statement? Give reasoned arguments and examples of situations to support your answer.

(8 marks)

TOTAL : 17 marks

Evidence of 'Environmental Awareness' would be expected in the answer to part (c). Candidates' answer should indicate a realization that as man is able to markedly affect his environment, he has an especial responsibility to show concern for other species, and to recognize that he is subject to the same constraints as other species.