SOCIAL AND CULTURAL RESPONSIBILITIES OF SCIENCE IN THE SCHOOL CURRICULUM: RATIONALE, OBJECTIVES AND TEACHING METHODS

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Introduction

The school curriculum throughout history has experienced ebbs and flows as various subject areas produce claims and counter-claims about their apparently legitimate position in the proper education of the world's learners. Science is no exception to the list of claimants which have made such demands and applied such pressures to the school curriculum. These claims and counter-claims seem to coincide with periods of great cultural, social and ideological changes either worldwide or in the developed sectors of the world. Very few periods of such apparent upheaval are initiated in so-called Third World Countries but the latter do become involved in them eventually.

I believe that the emphasis on social and cultural responsibilities of Science is such an upheaval that currently engages the attention of educators, policy makers and society at large in the present-day Caribbean. As such it seems important to look critically at the issues in an attempt to devise meaningful strategies to chart the way forward. This paper tries to grapple with this problem and concludes with suggestions of some objectives and teaching methods which seem relevant and feasible in our present situation.

What is science?

Several philosophers, scientists and educators have attempted to define what science really is. These definitions have a whole spectrum of different meanings, so different in some cases that one is left to wonder if all writers are answering the same question.

The STEP materials "Activities and Experiences" (1974) has a collection of these definitions from which I would give a small sample:-
Science is built up with facts as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house.

(J.H. Poincare, 1886)

Science is first of all a set of attitudes. It is a disposition to deal with facts rather than with what someone has said about them.

(B.F. Skinner)

The belief that science proceeds from observation to theory is still so widely held that my denial of it is often met with incredulity.

(Karl Popper)

Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observations.

(J.B. Conant)

Mathis (1977) in making a case for the vocational justification of science, traces the present roots of science and the arguments for its inclusion in the curriculum back to Herbert Spencer's 1859 essay on 'What Knowledge is of most Worth?' Mathis concludes that Spencer stressed that language-oriented curricula, laying emphasis on the classics should be replaced by studies more important to survival and success in everyday living. The argument is articulated thus: "In Spencer's view, the studies which contributed most to survival and success in everyday living were the sciences. The evidence which he marshalled to support his view was convincing and undoubtedly contributed to the rise of science education during the latter part of the nineteenth century."

Mathis opines that present day students, educators and policy-makers are coming to look at science as Spencer regarded the classics: "They regard science courses as lacking in practical value and as being irrelevant to the chief activities which constitute contemporary human life. The value of science is being questioned and student interest is apparently on the decline."
Like all other subject areas science's claims for inclusion in the curriculum change from time to time. There is a general consensus that at first science was advocated on the grounds of the apparent 'mental discipline and proper moral attitudes'. That position changed to more recent justifications like those presented in "The 59th Yearbook of the National Society for the Study of Education" (1960) by J. Barnard, and by the National Science Teachers' Association of the United States in its position statement on science education in the 70s.

Their two positions are very interesting and should be noted carefully. The first named takes the stance that society depends on science and puts emphasis on 'understanding the nature of scientific knowledge and the development of problem solving skills as major goals of science instruction.' The NSTA prefers to place the value in its ability to develop 'scientifically literate citizens with the necessary intellectual resources, values, attitudes, and inquiry skills to promote the development of man as a rational human being.'

I believe that at this particular stage of development of Caribbean countries, science has a major responsibility in developing the social and cultural fabric of such countries.

What is culture?

Perhaps it would be proper to have some idea of what is meant by culture as used in this paper. Here again there are many and varied definitions. However, I propose to use a rather simple statement which attempts a synthesis of many complex definitions. I see culture as the sum total of all the experiences (the mores, the beliefs, the values, the knowledge) which the particular society chooses to bequeath to succeeding generations. The method of transfer from one generation to another may be formal - schools and other similar institutions, - non-formal - story telling and such activities mainly on the family or village level.

Caribbean cultural heritage represents a melting pot of the various cultures derived from indigenous people like the Caribs, Arawaks, Amerindians, etc. from former colonializing powers like the English, French, Spanish, Dutch and Portuguese, and of course, from the African and Asian cultures, transplanted in various degrees of intensity from where a large percentage of our forefathers came. These various sources should, and in many cases do, produce a richness and variety that must be for all intents and purposes unique.
I see science as playing an important role in the informed development and maintenance of cultural heritage in the Caribbean region. Informed development in the sense that people become aware that science pervades everything that they do, and that many of their activities are done scientifically without due acknowledgement. This point is taken up later in the paper.

**Rationale for Highlighting the Cultural and Social Responsibilities of Science in the School Curriculum**

There are many reasons for highlighting the social and cultural responsibilities of science in the school curriculum. However, for the purpose of this paper I would prefer to concentrate on some of the major ones:

1. the need to emphasise the close connection between science and society;

2. the need to justify the presence of science in the modern day curriculum;

3. the need to understand the underlying assumptions of beliefs and customs;

4. the need to clarify science's role in politics and religion;

5. the need to understand the role of Caribbean man in his emerging environment - both regionally and internationally;

6. the need to be aware of the public's perceptions of science;

7. the role of each individual in influencing social and cultural decisions;

8. the rationalization of the blend of knowledge studies and issue studies;

9. the need to develop a science that is in harmony with Caribbean realities, ideologies, needs and aspirations.
(1) The Need to Emphasize the Connection between Science and Society

I have already outlined what I consider to be my definition of culture. Having done this, one can now see how close the association is between culture and society. I think society produces the ground rules and the methods of validation or rejection which are the decision-making tools used to categorize cultural activities. As such then, when I speak of science and society and their intimacy I am also encompassing the most valuable aspect of culture.

John Lewis (1979) in making a case for emphasizing science in society uses a figure which he borrows from Norman Booth, and which he calls "Components of Science Teaching".

![Components of Science Teaching](image)

**FIGURE I: Components of Science Teaching**

He represents pure science with an innermost triangle, science for action (application of science) as a square surrounding this triangle, and the science for the citizens as an all embracing and all pervading circle. Lewis (1979) explains the various levels of the figure thus:

>'But how much does one bank a road going round a corner?'
The answer to that does not lie inside the triangle; the Newtonian analysis of circular motion does not provide it. We learn about conduction, convection and radiation inside the triangle, but not where to put a convector heater in a room. There is a world outside the triangle represented by the square and which we call science for action. But there is more to science than that. In democratic countries, citizens will have to make decisions which will intimately affect their lives, and many of these decisions will have a strong scientific component. Preparation for this kind of decision making lies inside the circle, which we call science for citizens.'
Mathis (1977) prefers to insist that science curriculum should include four major facets which:-

1. create student interest;
2. maximize process skill development;
3. provide a framework for future learning, and
4. have practical application in a wide variety of work situations and at home.

The Commission for Biological Education in devising a course for non-science graduates at university uses common everyday activities to form the themes on which the whole programme is built. These activities are based on aspects of human endeavour - the home, the workplace, leisure time and transport. The feeling is that the themes themselves would form motivating factors, which might not have been the case if relatively arid topics like energy were used. The biology intended to be covered is also very closely related to society and its peculiarities, a feature so essential in today's world.

From the above arguments and judging from my own observa- tion of the direction of society and science education, I see a major thrust of Caribbean Science being towards social and cultural responsibilities.

Lambert (1979) seems to be of like mind when he articul- lates this position in relation to integrated science:

In integrated science education, however, the issues are compounded by the new social concerns that are appearing in curricula. Blum has drawn attention to some sources of psychological stress that can appear when home and school adopt different stances: science, both product and process, may be at variance with traditional beliefs and ways of doing things; openendedness and the questioning of all things poses threats to the authority of the family; content selected may serve to heighten an awareness of the state of underdevelopment of the community thereby serving as a depressant to the pupil. Cultural traditions and economic status are, however, not necessarily hindrances. They have been made use of in AES of Israel, in the Turn on Science Programme for native Indian
children of the United States; and in the Samoan Sea Study Lab programme, which attempts to stimulate interest in the sea and to heighten awareness of career possibilities for a South Sea island population under threat from metropolitan values.

(2) The Need to Justify the Presence of Science in Modern-Day Curriculum

I think that Mathis' (1977) call for an explicit justification of science education is timely. I agree somewhat with his advocating that vocationalism should be the rallying cry. I believe, however, that just as the justification based on utilitarianism became unstuck some years ago, a claim on narrow vocationalism may be fraught with danger. I prefer to take the broader stance which he seems to hint at in his paper Justifying science in an era of vocationalism does not mean that we must advocate a return to the curricula of the 1930s during which time emphasis was almost totally on technology. It does not imply that the goals of science teaching should be limited to objectives relating to such topics as health, home membership, citizenship, ethical character, and wise use of leisure time. It does not mean that attempts to relate science to the arts, social sciences, and humanities should be discontinued or de-emphasized. It does not mean that the modern trend of justifying science in terms of general process skills should be abandoned in favor of a justification emphasizing the value of those products having wide applicability in human affairs. It does mean that there is an urgent need for science to become more humanistic through increased curricular emphasis on the applied aspects of science and the relationship of science to society. It does mean that a recommitment to the values which Spencer saw in science are in order. (p 103)
Bybee et al (1980) see the justification of science education lying in its role to bridge the gap between science and society:

In the 1960s and 1970s the public has come to realize the importance of science and technology to society ... Yet, science and technology are also blamed for many contemporary social problems. As we begin the 1980s, the implicit contract between science and society is being questioned. Science education has a crucial role in the renegotiation of this contract, since public understanding of science is largely as a result of science education, both through formal classroom experiences and such informal experiences as museums and media presentations. p 377-378

There seems therefore, not only a dire need to re-justify science's position in the overall curriculum, but also to emphasize the humanistic, social and cultural responsibilities of the discipline.

(3) The Need to Understand the Underlying Assumptions of Beliefs and Customs.

It is generally agreed that there is a lack of 'scientific spirit' in Caribbean peoples. As a result, a lot of the things considered traditional or cultural are built on superstition or magic. Science needs, I think, to inform such ideas and attempt to remove misconceptions and doubt.

To me the Caribbean peoples find themselves on the 'horns of a dilemma' where these areas of culture and tradition are concerned. There are two ways, I suspect, to proceed when dealing with superstitions which form integral parts of one's cultural heritage. The first way is to try to eradicate these superstitions and beliefs by transplanting so-called civilized and 'developed countries' notions. This to me creates dissonance and ultimately shock, and produces people who are but pale replicas of others apparently more fortunate than themselves. Indigenous customs are frowned upon and these are replaced by those that are ostensibly better, but alien to people. The result of this method is mongrelization and the production of peoples who, due to a lack of feeling of belonging, become restless and aimless. We become what V.S. Naipaul calls 'the Mimic Men'. The other procedure is
to inject some form of scientific rationality into practices and mores that are presently underpinned by feelings of magic and superstition. For example, when housewives use raw pawpaw when cooking certain types of meat, do we encourage them to stop the practice and use 'meat tenderizers' in beautiful well-labelled jars? Or do we attempt to explain the underlying workings of the pawpaw in terms which are non-magical?

To me one needs to go for the solution which lies in attempting to provide rational positions to practices and beliefs, instead of attempting to replace them by alien cultures.

There seems then a place for science to provide ingredients of cause-effect in cultural and traditional areas. This I feel is one of the major social responsibilities of science in the school curriculum. Figueroa (1971) makes the point about lack of scientific spirit in Caribbean society very admirably when he makes a strong case for a deliberate strategy for teacher education:

Society in the West Indies is mixed or plural ... not only on the grounds of language, social structure, and general values, but also in the whole approach to 'causal' explanation of natural and human phenomena. Some seem to believe in an almost entirely chance - magical explanation of events; others tend towards the more so-called scientific explanations and understandings. What tends to be at stake here is responsibility. One can hardly be held responsible for actions over which one has absolutely no control or which are explicable entirely on grounds of chance. One does not have to be either a complete rationalist, or an out-and-out utilitarian, to realize that developed industrial society must rest on some notion of cause or at least of invariable correlation. It is difficult to see how West Indian society can develop without more of an injection of the scientific spirit and temper. Even though it is arguable that a science which is purely observational and uncommitted could be a great menace ... But unless science is taught in a certain creative way, it will have little effect either on the world view of the West Indian or on his ability to get more out of his bauxite deposits ... teachers are going to need special preparation in natural sciences and mathematics so that they do not teach them like other forms of magic. p 136
The Need to Clarify the Role of Science in Religion and Politics

Religion and politics are two important aspects of Caribbean life. This I believe is not a unique position. These two aspects of human endeavour are universally important. Science has a responsibility in each area.

Take religion, for example, many people believe that it is completely incompatible with science. To several religious persons the word scientist conjures up an image of a proponent of Darwinian Evolution theory, which is against all aspects of the Divine creation of man. The debate, the controversy between the two sets of persons rages fervently.

Cameron (1981) in exploring the possibilities of having religious beliefs in a scientific world draws an interesting parallel between the processes of Christianity and the scientific method. I think that Caribbean science has an important role to play in breaking down barriers that divide the two areas. (Poole 1981) summarizes quite succinctly some of the main areas of confusion in the two areas which could guide science in this action of conciliation:

The main confusion which seems to arise here springs from the incorrect belief that scientific laws tell us what should take place, rather than what does take place. Scientific laws are not commands to nature as to how it should behave, but concise, man-made descriptions of the ways in which it normally does behave. In short, scientific laws are descriptive not prescriptive. Certainly they indicate what might be expected to occur or what is unlikely to happen, on the basis of our previous experience, but they do not pronounce that something outside our present understanding cannot happen. In other words, as far as predictions are concerned scientific laws tell us what is probable rather than what is possible. The man-made, provisional nature of scientific laws involves their change and modification when insufficient experimental results fit in with them. There is nothing absolute about scientific laws. p 50
The idea that scientific laws are not absolute forces those involved in science to realize that 'truth' is a function of the present state of our knowledge and is heavily influenced by technological advances. Scientists have no monopoly on predicting what is possible.

I see the intervention of science in politics - the science and art of government, as being at two major levels. First of all, I see science aiding in the production of scientifically literate persons who are aware enough of political decision-making, and who are willing to question such decisions intelligently and articulately. The second point of intervention should be at the level of informing the decision-makers themselves. As the Caribbean moves towards massive industrialization, decision-makers face decisions which impinge upon the daily lives of all. The science that is taught at the school level, by its orientation, its aims and methods should attempt to address both levels. I think that such science should always be cognizant of what Lord Ashby (1981) calls the 'four important differences between decision-making in science and in politics'.

(1) In science there is no dateline for the decision. If you have not got enough information to prove your hypothesis, you go on making observations. You defer your conclusions until you are satisfied that you have all the necessary information ... In politics there is always a dateline ... It would not be an over-statement to say that the decision is always made before there is enough evidence to make it. It has to be.

(2) In science decisions are reversible ... In politics many decisions are irreversible.

(3) In scientific research you create your own problems and then proceed to try to solve them ... In politics you cannot choose which problems to solve; you have to solve the problems thrown-up by society, and some of these seem to have no solutions.

(4) Most scientific work has no immediate secondary effects ... In politics almost every decision has immediate secondary effects. p 70
I agree with Lord Ashby, however, that although science is an important ingredient of political decision, it is not the sole and sufficient ingredient. "To it has to be added political judgement, which is much more difficult to define or to understand." Ashby 1981

(5) The Need to Understand the Role of Caribbean Man in his Emerging Environment

One should avoid getting into semantics as to who is a Caribbean man, lest it clouds the issue. I use this term to typify a citizen of a Caribbean country who is part of an emerging region in a world that is itself emerging.

There seems to be a case for science as part of its cultural and social responsibilities to produce answers to the question 'Who am I?' Science's role goes much further than providing answers that pertain solely to physical characteristics, it needs to embrace aspects of the mental and biosocial. This understanding of himself should go a long way towards achievement of a harmony between man and his environment, both regionally and internationally.

(6) The Need to be Aware of the Public's Perceptions of Science

There is a tendency among scientists and science educators to be unaware of the public's perception of science. In some cases this stems from a genuine feeling that what scientists do is the concern of scientists only. In other cases it results from an indifference that has been engendered by years of uninhibited research when awe and mystique curtailed public challenge and scrutiny. I believe that science can no longer pretend that scientists bear no responsibility to society. This point impinges somewhat on the thesis of scientific neutrality in the context of science as a body of knowledge.

The science advocated in this paper should of necessity take into account value judgements, cultural and political biases of the society. A view that is strongly opposed to that of Bronowski, as quoted by Lipscombe and Williams (1979) as 'an unrelenting independence in the search for truth that pays no attention to received opinion or expediency or political advantage.' p 7
(7) The Role of the Individual in Social and Cultural Decisions

Science has an important function in the sensitization of each individual to his/her social and cultural responsibilities.

Science in that it represents, besides a body of knowledge, a set of activities or processes that scientists are involved in, has a key role in training the individual to make rational decisions on cultural and social matters. By its emphasis on observation, experimentation, by its accent on careful analysis and delayed conclusions it could make such activities a way of Caribbean people. Herein lies not only a role of science but also a tremendous challenge.

(8) The Rationalization of the Blend of Knowledge Studies and Issue Studies

Kelly (1977) in tracing the history of the 'marriage and divorce between biologists, and social scientists' poses a distinction between scientific enquiry and social decision-making which he calls Knowledge Studies and Issue Studies. In outlining the characteristics of knowledge and issue studies he seems to have a powerful framework to guide action in devising school programmes which emphasize the social and cultural responsibilities of science:

<table>
<thead>
<tr>
<th>Knowledge Studies</th>
<th>Issue Studies</th>
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<tbody>
<tr>
<td>• Emphasis on knowing and understanding</td>
<td>Emphasis on problem solving and decision-making.</td>
</tr>
<tr>
<td>• Unknowns tend to be known</td>
<td>Unknowns not necessarily known</td>
</tr>
<tr>
<td>• Reflective</td>
<td>Motivation derived from social and/or individual action.</td>
</tr>
<tr>
<td>• Low moral load</td>
<td>High moral load</td>
</tr>
<tr>
<td>• Precise terminology</td>
<td>Confused terminology</td>
</tr>
<tr>
<td>• Unitary integration</td>
<td>Eclectic integration</td>
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</tbody>
</table>
Mainly invariable, possible hierarchical, arrangement of concepts

Variable arrangement of concepts

Kelly 1977

The science advocated should have a fine blend or balance of knowledge studies and issue studies, for the latter link science with the realities of people and their lives.

(9) The Need to Develop a Science that is in Harmony with Caribbean Realities, Ideologies, Needs and Aspirations

Whatever science is developed it must not be in conflict with Caribbean realities, ideologies, needs and aspirations. There is a sense in which this reason summarizes many of the concerns expressed in the first eight. True, science has a social and cultural responsibility, but the question is whose culture and whose society. To me the answer is unequivocal, it must be Caribbean culture and society. It must be a science that reflects present realities and likely trends, and it must be embedded in the strong culture that exists. This embedding is not to belittle such culture or to make people change it for foreign substitutes, but rather to produce a base that enriches.

Social and Cultural Responsibilities of Science

Aims and Objectives

Bearing in mind the ideas brought out in the rationale there are certain aims which must form part of the purposes of a course of study emphasizing social and cultural responsibilities of science.
Aims

(1) An appreciation of the nature and limitation of scientific knowledge.

(2) An understanding that scientific knowledge results from man's endeavour and is not immutable.

(3) An appreciation of the beneficial and detrimental effects that science could have on society and culture.

(4) An understanding of the role of science in eradicating superstition.

(5) An understanding that science is not entirely neutral but could have ideological, cultural and social determinants.

(6) An appreciation of the need to be aware of the public's perceptions of science.

(7) An understanding that scientists has cultural and social responsibilities which are inescapable.

(8) An appreciation of the need to blend pure science with science for action and science for socially sensitized citizens.

(9) An understanding of the need for, and an ability to make decisions based on rational considerations.

(10) A realization that moral, social and cultural aspects are important parts of decision-making.

(11) A recognition of, and an ability to search for the aesthetic values of one's own cultural and social heritage.

(12) An appreciation of the role and responsibilities of science in the school curriculum.

This list is not meant to be exhaustive but merely to provide ideas which could form the basis of discussion.

Suggested Teaching Methods

In attempting to highlight the social and cultural responsibilities, one important method is to use excerpts from the history of science. This should help to make students aware
of the human face of science and science research. It would be even more interesting if the focus could be put on Caribbean science activities and research. The importance of using the history of science lies in the fact that it should help students to understand how various discoveries were made and various laws or theories developed. This should go a long way towards eradicating the awe and mystique with which science is surrounded.

Another method advocated in this respect is the use of 'persistent problems' as the focus of attention. In the Caribbean region aspects such as malnutrition, beach erosion, litter and rodent infestation are but a few of these problems which may be highlighted. Take the area of malnutrition which remains a problem even in the more developed countries of the region people are genuinely not aware of the difference between quantity and quality of food. To many, a lot of one type, mainly carbohydrate, is enough to allow them to lead healthy lives. Some of the reasons for malnutrition are of course economic but some are socio-cultural. Some religious sects do not eat certain types of food because of their beliefs, but show little understanding of how to supplement their diets to prevent deficiencies. This method of highlighting persistent problems should also foster the close link between science and social customs and norms which is so desirable.

Another good method is the use of project work. This method has gained prominence in the last few years in Caribbean schools especially in the Caribbean Examination Council's integrated science syllabus. This is not the place to look at educational value of project work. However, one must underline the powerful influence that this technique has both on students' creativity, originality and attitude to science, and also to the removal of various misconceptions which society has about the nature of science.

The use of decision-making games provides another valuable method of highlighting the social and cultural responsibilities of science. These games, in that they put the student in the role of decision-maker, help them to appreciate that there are moral and ethical considerations involved in making decisions. They also help to make them realize that science, though important, has not all the answers and cannot be the sole determinant of decisions.

Another method which could be useful is to scrutinize widely held practices and customs in the light of their underlying beliefs and assumptions. These could be put forward in the form of anecdotes, and students could be asked to comment critically on them. This method, if properly used, could go a long way towards injecting some rationale base or erad-
icating misconceptions all together. One understands that such change will take some time. In the area of practices and customs which have existed for generations, overnight solutions are hardly likely to occur.

One cannot concentrate one's effort, however, entirely on the school. It is true that the students are important, and that every effort should be made to force them to examine their beliefs in the light of evidence. Yet for any course which highlights cultural and social responsibilities of science to succeed, every attempt must be made to impact on society as a whole. This impact could have direct and indirect effects on the success or failure of the approach. I see here then a case for using non-formal methods such as media presentations, science fairs, etc. as means of achieving this aim. Such out-of-school, non-formal methods of teaching science are being used in the Caribbean region at present. However, much more needs to be done in this area, if science is going to lose the image of being classroom bound.

Whatever methods are used, formal or non-formal, in-school or out-of-school, it is necessary to stress one important point - there is a danger in just imparting factual knowledge to students and to the society without their feeling personally involved. Lewis (1979) speaks of this danger thus: "We have to move away from the convergent thinking of the past in order to move into the divergent thinking that is necessary."

Summary

This paper has attempted to provide a rationale for highlighting the cultural and social responsibilities of science in the school curriculum. It postulates that science not only needs to justify its presence in the curriculum, but that emphasis on social and cultural responsibilities present a legitimate claim at the moment. This position is taken bearing in mind the nature, structure and possible direction of Caribbean society.

An attempt is then made to operationalize this philosophy, this underlying framework into aims and purposes. Certain methods are also suggested although the list is not exhaustive.

Overall the paper attempts to articulate a position which could be important and necessary as the Caribbean region grapples with the place of science in its national and regional goals, and its likely impact on the international scene.
References


Mathis, Phillip. Vocational Justification of Science in Science Education. 61 (1) 1977.