Science, Schooling And Manpower Production in Nigeria: A Study of Kano State Science Secondary Schools, 1977-1987

By

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Declaration

No part of this thesis has been submitted for a higher degree at any institution of learning, either in the same or different form, apart from the University of Sussex.

A. U. Adamu
Signature.................. Date: **11 March 1988**

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Abstract

This research investigates the mechanism of the change process in science education by analysing role of science education in promoting development objectives through schooling in a developing country. The change strategy analysed in this research is the Science Secondary Schools project established by the Kano State Government, Nigeria in 1977. The Science Schools were aimed primarily at enabling specially selected senior secondary school students (Grades 10-12) to be taught science subjects in a new and different environment from that of conventional secondary schools. The Science Schools were seen as the main way Kano State will eventually have a large supply of highly qualified manpower in science and technology, believed necessary for modern social and economic development.

The research investigates the Science Schools project from three perspectives. The first is the genesis of the Science Schools project as an educational change strategy. In this dimension, the research investigates the rationale and mechanisms behind the establishment of the Science Schools. The second focus is on the nature of the science curriculum in the schools, and analyses both the science curriculum and the way it is interpreted in the schools by both the teachers and the students. The third focus analyses the institutional realities of the Science Schools which provides an opportunity to examine the extent to which the schools have contributed, or can be made to contribute, to the development of skilled indigenous manpower in science and technology for Kano State.

The findings of this research demonstrate the powerful stimuli of economic and political forces in the development of science education innovations. But in the process, the research has also highlighted the fundamental problems faced when science education change initiatives are based on political, rather than academic priorities. The research has shown changes in science education require a different strategic focus than those applied in general educational changes to enable attainment of more effective outcomes. This is because science, as a powerful tool for intellectual advancement provides a developmental framework for science education as an instrument of social transformation. Basing science education policies on political priorities obviates the potency of science in the social process.

The data presented in this study did not prove that the way science was perceived and taught to the students in the Science Schools could produce the outcomes in the students the Science Schools did. This is because even though direct comparisons were not made or sought between the Science and nonscience schools, the research evidence clearly shows little difference between the two categories of schools in administrative interpretation of science education, teaching facilities, teacher strategies and students' perception of fundamental learning variables in science. This has a serious implication

because it questions not only the techniques by which the project is being implemented, but also whether all the outcomes associated with the project can be attributed to the project.

These findings are significant in that developing countries rely on administrative initiative for science educational reform. And if a procedure is established where political priorities consistently over-ride academic considerations, then attainment of development goals through science education become susceptible to the instability of economic and political forces prevalent in developing countries. This will have a retarding effect on national development.

Map of Nigeria

Map Of Kano State Showing The Local Government Areas Where The Four Science Secondary Schools Are Located (Dawakin Tofa, Dawakin Kudu, Ringim And Kafin Hausa)

(Source: Trevallion 1963)

Chapter 1

Introduction To The Study

1.1 Introduction

Since the industrial revolution in Europe in the 16th and 17th Centuries, science and technology have assumed important roles as powerful strategies of social and economic transformation. Their acquisition as well as widespread utilization have come to be considered the hall mark of modernization in any contemporary social structure. Their role lies in the way their sustained application improves the quality of social and economic life in the society. Diseases can be controlled and in some cases totally eradicated. Nature can be tamed and life made more bearable as the result. Environmental awareness has resulted in a more rational use of resources to aid better living. Improved agricultural methods of livestock and crop production can lead to an improvement of the quality and quantity of food available to people. Technology has facilitated transport and has enabled better communication among communities. The list of advantages of science and technology in the modern world is truly impressive.

But equally impressive is the list of doubtful benefits to humanity brought about by activities associated with science and technology.

Warfare, not necessarily an outcome of science or technology, easily comes to mind because of its reliance on the products of science and technology for its sustenance and often spectacular effects. Environmental degradation brought about by industrial pollution as a product of intensive industrialization is also a source of concern to many people, especially as it relates to the ability of the biosphere to sustain life. Rapid advances in medical science have brought the gifts - or curses - of spare part surgery, prosthetics, in vitro fertilization and biotechnology; and along with them, complex ethical and religious issues concerning the nature and future of man. Nuclear incidents such as those at the Three Mile Island (Pennsylvania, U.S.A. 28th March 1979) and Chernobyl (the Ukraine, Soviet Union 26th April 1986) further serve to emphasize the uncertainties about the extent to which science and technology, especially through those placed in their charge, can be relied on for the sustenance of life.

These possible outcomes are underlined here to emphasize the full implications of massive investment in science or technology. Nevertheless science and technology remain the major strategies through which the quality of economic life in any society can be significantly improved: their acquisition and widespread use in any society serving as an index of the level of development of that society. Doubtful benefits may be more an outcome of misunderstanding, misuse, or mismanagement of the products of science and technology than a reflection of the inherent nature of science or technology.

The visions of science and technology in social and economic development in Nigeria were clearly outlined by the then Head of State, General Yakubu Gowon, stating in an interview:

> "At the moment, our priorities include the improvement of the quantity and quality of our agricultural crops - export as well as food crops - and the improvement of our road and air and water transportation which are necessary in order to facilitate the movement of both goods and human beings - and in order to speed up the movement of our export crops. Then, of course, there is the need to provide an adequate and reliable water supply; in many places this is paramount. And, of course, electricity provision and the provision of an efficient telecommunications system. And of course, the development of our manpower resources to enable us to exploit and utilize our natural resources more fully is another of our priorities. In all these areas, you can see where science and technology can really play a very important role. There is a need for much more research in most of the fields I have mentioned so that we can effectively achieve our goals..." (interview with Friedmann 1972, p.55)

Thus due to the advantages offered by the application of science and technology in the society, there is a high level of commitment, in both developed and developing countries, to the provisions of educational facilities serving as the basis for much more effective training of manpower in science and technology disciplines. This was, for instance, emphasized in the declaration of the UNESCO Conference of Ministers of African Member States Responsible for the Application of Science and Technology to Development in Dakar 1974, where

> "The Conference...noted..the continuing weakness of African scientific and technological potential. Since men represent a country's main wealth as well as the agents of its development, the first task must be to develop African universities and apply an education policy aiming at the democratization and reorganization of instruction, including more especially the upgrading of scientific and technical training at all levels." (UNESCO 1974 p.10)

And because science is the focus, the initial attention of the commitment is on the nature of the science curriculum, and in some other cases, the institutional context of teaching and learning science subjects to children at all levels of schooling. The main focus, however, remains the science curriculum, and this was reflected in wide-ranging science curricular reforms that swept to most parts of the world at the beginning of the 1960s.

The reforms were carried out mainly as Science Teaching Projects aimed at primary and secondary level of schooling. The main projects that provided the impetus and the initiatives for the rest of the world, including both developed and developing countries, were the various science curriculum projects sponsored by the National Science Foundation of the United States, and the Nuffield Foundation Science Teaching Projects in the United Kingdom, both in the early to mid 1960s[1] .

[1]. Some of the American projects concerned with secondary school education and their initial dates include: a) the Physical Science Study Committee (PSSC), 1960; b) the Chemical Bond Approach (CBA), 1963; c) the Chemical Education Material Study (CHEM Study), 1963; and d) the Biological Sciences Curriculum Study (BSCS), 1963. Similarly, the British projects include: a) The Nuffield Biology, 1963; b) The Nuffield Chemistry, 1962; and c) The Nuffield Physics, 1962.

These served as models for either an immediate development of science education programmes, or as catalysts in a reformulation process which led to newer curricula or more radical contexts of learning science in many countries.

A predominant theme of the reform movements, especially those concerned with the curriculum was the re-evaluation of the techniques and procedures of science teaching and learning. This is seen, for instance, in an objective of the Nuffield Foundation Science Teaching Projects in the United Kingdom which was

> "to encourage children to think freely and courageously about science...An essential part of the philosophy guiding the science teaching projects is the belief that the best way to awaken original thinking in children studying science is to engage them in experiments and practical inquiry.." (Kerr 1966 p.302)

This objective typifies the basic ethos of the science curriculum movements as further reflected in the British accounts of science curriculum development in Dowdeswell (1967), Halliwell and Van Praagh (1967), and Wenham (1967); as well as the American accounts of Dowdeswell (1960), Kelly (1963), Gatewood and Obourn (1963), and Goodlad et al (1966).

As an added dimension to this objective in both developed and developing countries (although more so in the latter), the emphasis of some of the reform movements also included the view that science education should prepare the learner for absorption into the labour market, or at least enable integration of the products of learning these curricula into a technological (and therefore modern) society.

This was seen by school administrators and political leaders as particularly important because it is the only way in which national self reliance can be attained through the production of scientifically literate and qualified manpower. Consequently, there were educational and political expectations that the science programmes produced by the reforms should constitute a balanced science education for all learners, regardless of ability or the level at which their education will terminate. This strategy is seen as the basic step towards achieving a measure of national economic self reliance through science and technology.

But although the science curriculum has been the first focus of reform in the interpretation of the role of science education in social and economic development, a second strategy sharing the same emphasis focused not on the curriculum directly, but on creation of schooling circumstances aimed at achieving the same goals as the curricular reforms. This second strategy, as part of a long term educational planning, was aimed at continuous production of school leavers with the pre-requisite inclinations towards science as a subject of study, and consequently as a career. Examples of this category of reform in science education included the Turkish Science Lycee (Maybury 1975), the Phillipines Science Education Center (Maddock 1981b), The Fitz-Mat Preparatory Science School in the Soviet Union (Baez 1976), the Kenya Science Teachers College (Gumo and Kann 1982) and the MARA Technical institutes and science schools in Malaysia (Malaysia 1976).

In Kano State, Nigeria, a science education strategy belonging to this latter category of innovations in science education, and using a new science curriculum which shares similar beliefs of the general science curriculum reform movement was introduced by the State government in September 1977. This was in the form of special Science Secondary Schools, created to offer science education to specially selected senior secondary school students (Grades 10-12) under different conditions from conventional senior secondary schools in the State. The main objective of the Science Schools was to provide an educational context where Kano State students potentially skilled in, and with high inclination and aptitude for, science and technology disciplines could be developed as a large stock of manpower for effective social development of Kano State.

As a teacher trainer in science education in Kano, I became interested in the science schools, and started observing them from 1980. Frequent contacts with the officials of the schools, including the principals and the teachers familiarised me with the activities of the schools. From these observations questions begin to arise in my mind about the meanings given to the Science Schools in Kano, as well as the way science education is interpreted in them by the school authorities. The juxtaposition of these questions with an awareness of the overall themes of the science education curriculum reform movement further increased my interests in the outcomes of the Science Schools as strategies of educational change. Before looking at the questions, it may perhaps pay to provide a brief background of Kano State which will also put the nature of the problem in a proper perspective.

1.2 Background to the Research

When the history of Kano State in relation to the development of modern education is considered, it is surprising that the concept of the science secondary schools could originate from the State; not only because of the traditional hostility of the people of the state towards modern education (i.e. education with roots in the Nigerian colonial experience), but also because radical educational changes such as the introduction of the Science Schools in a society considered traditionally conservative do not come easily.

Kano is a Muslim State with a population of approximately 10 million and is located in far Northern Nigeria (see Map). Due to the Islamic nature of the people of the State, modern education was strongly resisted to such an extent that the British colonial administrators coming to Northern Nigeria in 1903 prevented Christian missionaries from establishing their missions and schools in the Muslim areas. However, the missionaries were allowed free access to 'pagan' areas of the rest of the country. The consequence of this was the spread of Christianity and modern education very quickly in the other parts of the country, excluding the Muslim North including Kano. In 1910 the British administrators of the region introduced secular schools (but sympathetic to Muslim sensitivities) in Kano in order to train local manpower for the (lower strata) of the civil service. Due to various problems which included two world wars and the still resistant attitude of the people of Kano towards modern schools because they believe them a forum for converting their children to Christianity, education did not develop rapidly or qualitatively generally in Northern Nigeria.

After the Nigerian independence from the British in 1960 and the creation of Kano State from the Northern Province in 1968, the Kano State government became increasingly aware it lacks indigenous (i.e. from Kano State) manpower to run the civil service and other aspects of general social services effectively, and especially the increasingly large number of development projects embarked upon by the State government. This situation was attributed by the policy makers to two direct reasons. First, modern form of education was still to gain wide acceptance among the people of Kano State; this means the schools were not functioning at full capacity to produce the necessary manpower stock. Secondly, the schools themselves became points of criticism for not providing the necessary or adequate experiences in science education to students to produce the amount of potential expert technical manpower needed in the State.

The situation for Kano was further confounded with increase in Nigerian economic prosperity in the early 1970s which, because of oil sales (Nigeria's main export commodity), saw the initiation of many ambitious developmental projects all over Nigeria. These included the development of hospitals, power generation facilities and distribution to all areas, communication links, large scale agricultural expansion, and rapid development of industries. The direct effect of this set of developmental activities therefore in Kano, was the observation of a marked lack of indigenous scientific manpower to provide appropriate guidance and sustain these projects and generally contribute to social advancement.

To combat serious shortages of expert scientific and technical manpower for Kano State, the State government adopted a simple but costly strategy of recruiting the much needed scientific and technical manpower from overseas, mainly Asia. These included doctors, engineers, agricultural advisers and science teachers, a process which continued up to 1980s. The extent of the dominance of the expatriates in Kano State is seen, for example, in the science and technology manpower strength of Kano State in 1974. Of the total of 287 highly skilled manpower in science and technological fields in Kano, only 71 (24%) were indigenes of Kano State. About 61 (21%) were other Nigerians, while the majority of 155 (54%) were expatriates (Kano State 1974).

This pattern is also reflected in the science teaching force in the State secondary schools and Teacher Training Colleges up to 1985. Of the 510 listed Kano State science teachers during the period of 1983-1985, 386 or 75% were expatriates, mainly from Asia. The rest were made of up teachers from Kano and the rest of Nigeria (STAN 1985). The only long term solution to manpower shortage in Kano especially in areas considered necessary for modernization and development lie in a transformation of the educational services in a way that emphasizes the high role given to science in schooling and subsequently, development.

It was under these conditions prevailing in the 1970s that the Kano State government introduced the Science Secondary Schools Project in 1977. The fundamental objective of the project was to provide a learning context where eventually more indigenes from Kano State will be trained in science and technological disciplines. Because of their high priority to the Kano State government a special administrative unit, the Science Secondary Schools Management Board, later made into the Science and Technical Schools Board, was created to manage them, a move designed to make the Science Secondary Schools as independent as possible from the Kano State Civil Service, and to some extent, also from the Ministry of Education.

And while there was a great deal of political instability in Nigeria in the years immediately after the Science Schools were established, they have nevertheless survived different, and often contrasting, political climates (a unique feature in Nigerian educational development as, for instance, the demise of the National Open University in February 1984, few months after a military coup, shows).

From 1977 to 1987, four Science Secondary Schools were firmly established in Kano State; three for boys and one for girls. All the schools, with the exception of one of the boys' schools which was opened in 1984, have provided students for the West African Examinations Council General Certificate of Education (GCE) ordinary level examinations. And from 1980 when the first set of students from the Science Schools took their ordinary level examinations to 1986, six sets of students have graduated from the schools, numbering 2,437.

1.3 The Statement of the Problem

Over the last 25 years since 1960, there has been a tremendous amount of activity in science education oriented at a more utilitarian interpretation of the role of science education in social development. During this period, it became necessary for social, economic and defence purposes to ensure a system of commitment and training in science education that would enable a more effective training of potentially high quality manpower in science and technology disciplines.

This becomes more so in developing countries where various governmental obligations to the society necessitate determining the most cost-effective techniques and strategies of achieving self sufficiency and self reliance in the production of indigenous scientific manpower for national development. This research investigates the mechanisms and outcomes of one such strategy in Nigeria.

1.4 The Research Questions

The main objective of this research is an investigation of the processes by which the Science Secondary Schools in Kano attempt to achieve the goals they were established to attain. The following research questions which will guide the research, are therefore asked:

1. What led to the establishment of the Science Secondary Schools in Kano State? What was the mechanism of their establishment? What were their objectives? What are their most fundamental characteristics?
2. How is the Science Schools project implemented?
3. What is the emphasis of the science curriculum used in the Science Schools in intention and in reality?
4. How are science subjects taught in the Science Schools? And how does this relate to the curriculum emphasis of the science curriculum, and the objectives of the Science Schools?
5. What are the attitudes of the students in the Science Schools to science and careers in science?

6. What has been the contribution of the science schools to the manpower output of Kano in science and technology since they were first established by the Kano State Government in 1977?

1.5 Rationale For The Research

The research is undertaken for two main reasons, both aimed towards gaining an insight of the mechanisms and eventual outcomes of science education innovatory strategies adopted by developing countries in attempts to facilitate indigenous scientific and technical manpower training and production.

Firstly, since the Science Schools were established by the Kano State government as a key investment in science education in September 1977, there has been no empirical investigation of the mechanisms and rationale on which the decision to establish these schools were based. This has limited the quality of judgements and decisions that can be made about the impact of these schools, and consequently, this particular type of educational change strategy on the society.

Secondly, the research itself comes at a significant moment in the development of science education in Nigeria. In 1985, the senior secondary schools in Nigeria (Grade 10-12) started operating a new science syllabus (referred to, perhaps mistakenly, as the new science curriculum). According to its developers, the new science syllabus offers a more pragmatic view of the role of science in national development, with its unique (to Nigerian education) approaches to teaching science. The Science Schools and the new science curriculum therefore share the same goals. An analysis of the former will yield an incomplete picture without a corresponding analysis of the latter.

Further, an analysis of the new science curriculum should reveal the extent of the clarity of its intentions, and also the extent to which it prepares the students for the labour market, which is one its most fundamental objectives. This is clearly important to the Science Schools because they rely on the science curriculum to enable them to achieve their primary goals, i.e. preparation of students for manpower training in science and technological disciplines, as well as for labour market absorption.

The research, through these two main rationales should provide insight into the conditions necessary for effective use of science education strategies in National development.

1.6 Organization of the Thesis

While this thesis is divided into chapters, it is more appropriate to think of them in terms of answers to specific research questions. Within each chapter various themes addressed by the research questions are developed. The thesis is thematically divided into two parts. Part I provides the theoretical and contextual framework for the study (Chapters 1, 2, 3 and 4). Part II presents and analyses the data (Chapters 5, 6, 7 and 8).

Chapter 2 explores the theoretical basis for the research, including literature review. Chapter 3 describes the analytical framework and data collection procedures adopted for the research. Chapter 4 provides a contextual framework by exploring historical development of modern education in Kano State.

Chapter 5 analyses evidence on the origin of the Science Schools project. A particular emphasis is the antecedent social and economic forces that gave rise to the project. Chapter 6 analyses the science curriculum used in the schools, while chapter 7 explores the interpretations of the curriculum in the Science Schools. Chapter 8 looks at the outcomes of the project, while Chapter 9 concludes the research and identifies areas for further research.

Chapter 2

Theoretical Framework And Literature Review

2.0 Introduction

This chapter is divided into two sections. Section I discusses the various theoretical frameworks often used to explain patterns of educational change. Two theoretical perspectives informed the discussion in this section. First is the consideration of various models explaining patterns of educational change, especially as it relates to focused innovations rather than broader educational reforms. Second, the strategies used to implement changes once the need for the change has been identified are considered.

Section II reviews the literature in science education changes and identifies four themes. These are origin of science education innovations, determination of the need for the innovations, the characteristic features of the innovations and the lessons that emerged from the innovations. The chapter therefore seeks theoretical bases around which the Science Schools as educational change strategies in science education can shed further insights into the nature of educational changes in National development.

2.1 Section I: Theoretical Framework For Educational Changes

Changing economic, social and political situations in both developed and developing countries have combined to create needs for constant innovations and reforms in education. As Durkheim (1938) argued,

> "Educational transformations are always the result and the symptom of social transformations in terms of which they are to be explained. In order for people to feel at any particular moment in time the need to change its educational system, it is necessary that new ideas and needs have emerged in which the former system is no longer adequate." (Durkheim, 1938 p.167)

This is more so in developing countries where from the late 1950s to mid 1970s independence from colonial administrators, and in some cases new found wealth based on natural resources have contributed to a redefinition of social priorities and objectives. As Fagerlind and Saha (1982) contended, although it is difficult to pinpoint when strong links between education and social and economic development began, nevertheless,

> "...it is certain that by late 1950s and early 1960s there was general agreement among politicians, educational and social planners, and schools that education was a key change agent for moving societies along the development continuum." (Fagerlind and Saha, 1982 p.39)

And within this context, expanded and improved educational provision became a focus of development efforts, especially in developing countries as a means of acquiring new skills and increasing productivity. A further strong rationale behind massive investment in education is argued by Adams (1977) who also contended

> "educational systems were said to produce the skilled manpower and the new knowledge requisite for technological advancement and economic growth." (Adams, 1977 p.299)

The rationale behind this argument is reflected, for instance, in a review of several documents issued in the 1950s and 1960s in several African, Asian and Latin American countries. These documents, in the form of National Plans, expressed a desire to use educational provision for economic development (Lewin, 1984a). A common theme has been that education is not seen to be pursuing relevant goals, and its various outcomes subsequently unsatisfactory (Hurst 1983). Educational innovations are often introduced to make education more utilitarian, and this has generated a whole theoretical field with a focus on how the innovations were initiated and how they achieve their effects.

However, in my discussion I would wish to make a clear distinction between the forces responsible for the initiation of localized educational innovations and wide scale educational reforms. The former (educational innovations) are aimed at improving the maximization of educational resources (finance, personnel, instructional facilities) while the latter (educational reforms) have the added dimension of direct social antecedents and reflect a revolutionary, rather than evolutionary trend in the society. As Karabel and Halsey (1977 p.551) observed,

> "The process of educational reform during periods of revolutionary upheaval raises with particular sharpness the general problem of relationship between educational and social change...Revolutions do not merely make educational change possible, they require it. They must transform the educational system and bring it into harmony with a new institutional and ideological framework."

They cite Russia, Cuba and China as typical examples of the interplay between educational reform and social change. This distinction between educational innovations and educational reforms is necessary because my focus is on the Science Schools as small scale innovatory strategies. As such in tracing the mechanism of their origin and outcomes, my focus will be within the context of localized conditions giving rise to the project, rather than social pressures with national proportions.

This stand is augmented by a similar distinction in Paulston (1976) who views an innovation as a

> "relatively isolated technical or programmatic alterations or as low level change, whereas reform involves a normative, national and broad structural change." (Paulston 1976 p.1)

This distinctions makes it easier for instance to separate Paulston's (1976, 1977) classification of theories of educational change with social antecedents, and the innovatory theories characteristic of "isolated programmatic alterations." In Paulston (1977), he forwards the thesis that the unique characteristics of any educational reform effort can be partly explained by the theory of education and development in a given society.

However, in situations reflecting “low level change”, Zaltman, Duncan and Holbek (1973) were able to generate two broad categories of theories explaining change in education, separated by the origin of the change. These categories are those that see change as an internal process originating from the organization, and those explaining change as externally motivated, with a large input from social conditions.

Within this broad categorization, Zaltman, Florio and Sikorski (1977) were further able to generate subcategories of theories which they describe in terms of specific models analysing educational and organizational changes. These subcategories see models as being environmental (external), organizational (internal) authoritative/participative (both internal and external), and individually-oriented (internal).

The environmental category includes models which reflect organizational change as arising from external social conditions. A good example in this category is Levin’s (1972) Polity model whose main inspiration is the social environment from which the educational change is to occur. The model argues that educational changes essentially reflect changes in the society or “polity”.

The main implication of this model for any change agent is its requirement that any attempted change should be developed and presented in a way consistent with the values and goals of the society. It also implies major educational changes should be introduced when major changes in the society occurred. Finally, the change agent must identify social influences which are very important to change being considered.

Organizational change models are concerned with group process. An example is the Zaltman, Duncan and Holbek (1973) model whose emphasis is on the effects of internal environment of an organization on the change process. The model suggests two basic stages in change: initiation and implementation, each with series of substages. Initiation substages are knowledge-awareness, attitude formation and decision, while implementation goes through initial implementation and continued-sustained implementation.

An important implication of the Zaltman et al (1973) organizational model also is that organizational characteristics which facilitate introduction of innovations may make implementation difficult, while characteristics enabling easy implementation may make initiation difficult. Further, its linear structure is blind to realities of innovations. Many changes are initiated, but not implemented fully or at all. For instance, lack of teacher commitment may produce only passive compliance with change, and thus the potential benefits of the change may not be fully realized.

If changes are analysed using this model, it becomes necessary for the change analyst to be certain a monitoring mechanism exists to determine the degree of the implementation of the innovation.

The Authoritative/Participative models characterize change in terms of the extent to which decisions are made by authority figures. In this framework, decisions about the nature of process of change are made entirely by individuals holding positions of authority. Such authority figures may be within the organization (e.g. teachers), or outside (e.g. the Ministry of Education).

Interestingly enough, although authority figures more in this model, those who will implement it must have an input, no matter how negligible, in some stages of the decision making regarding the innovation. The magnitude of this input often puts this category of change into a participative mode. For instance, although teachers may not be part of the decision to set up the Science Schools Project, their input is required regarding which science textbooks to use and this may become part of an established policy, according to the assumptions of this model.

An illustration of a model which describes these characteristics is the one proposed in Rogers and Shoemaker (1971) which has two dimensions. The first dimension is Authority Innovative Decision and emphasizes the importance of the superior-subordinate contact. Under this dimension, three stages of decision making are separated from an implementation phase. Knowledge of the need for change, persuasion regarding intended changes, and decisions regarding acceptance or rejection of changes are handled by authority figures prior to implementation. The implementation phase includes communication of the decision to adoption units within the organization and action by the adoption units to implement or reject the change. And while consultation may occur, authority innovative decisions are made for and not by the adopting units.

The other dimension of the model is Collective Decision Making, which is more participatory and whose substages are stimulation, initiation, legitimation, decision and action which all reflect the involvement of personnel concerned with identification and subsequent adoption of the innovation. There are various ways the collective decision dimension can be implemented. A change planner, for instance may assume the role of stimulator and initiator, or may help facilitate the performance of these roles by providing information, creating opportunities for stimulators and initiators to interact with each other.

Individual oriented models focus on the individual decision maker or adopter, and many models were described under this category (see Zaltman et al 1977). The models describe the cognitive processes persons undergo, whether their decisions are made in a group or organizational context, or in relative isolation. Although the individual is the main focus, several elements in this model are parallel to those described by organizational change models.

In the individual oriented model, the initial stimulus for change in the individuals comes from some awareness, perception or problem recognition by the individual. This is the awareness that a gap exists between real and desired circumstances, and therefore a need for some change or innovation to close that gap. This is followed by an informative stage involving considerations of various change possibilities and their attributes. If enough interest is generated from the information, comprehension follows which initiates attitude formation process. This leads to support gained through attitude formation and becomes legitimation or adoption.

A basic flaw with individual-oriented models is their lack of clear consideration given to the implementation process. Many of the models, according to Zaltman et al (1977) describe a purchasing or selection action only. The initial or sustained use of the innovation is neglected.

Another problem of the individual oriented models is the linear presentation of the model whereas various elements may occur at the same time or in different order. The overall implication of these models is the need to convince the change targets that there is a need for the change. Also knowledge of the actual solution must be made available, and must be realistic to the environment in which the change will occur.

There are many other models explaining the process of educational change, although they all contain elements of either an internal or external input as a pattern of initiation. For instance, Ponsioen (1972) discusses a series of models delineated as Imposition, Conviction, Participation and Interaction, all of which define the flow of ideas within an educational system when change is being considered, each of which stands on its own and incorporates elements of other models in it. Their definition also places them within the broad categories of pattern initiation of either describing a change which is externally or internally motivated. Fullan (1982) also identifies four major aspects pertaining to the nature of the change strategy itself which he argued related to subsequent implementation. These are need, clarity, complexity, and quality and practicality of the material (product quality) which characterize educational change.

Other models are derived from an observation of the pattern of initiation and implementation of various educational changes. For instance, Havelock and Huberman (1978) in a survey of various educational innovations in African, Asian and Latin American countries were able to synthesize a structural model which describes the internal qualities of various projects depicting innovations in education.

Interestingly, this model was not categorized according to the source of change. Its main feature is it enables understanding the structural mechanism of the innovations themselves, rather than the pattern of their initiation. By this characteristic, the model also describes the pattern of use of the various components of innovatory programmes.

The model has four basic structural components. These are Infrastructure (I), Authority (A), Consensus (C), and Resources (R). However, in their discussion of the derivation of the model, Havelock and Huberman paid prominence only to the first three elements. This is because Resources, according to Havelock and Huberman, are a problem in change situation in the countries they surveyed, and its inclusion will only complicate the theoretical dimensions of the model.

A detailed analysis of each component provides a further understanding of how they are expected to combine to produce a framework for analysing educational changes.

The Infrastructure refers to how efficient the change strategy is in attaining its stated objectives. It also refers to the efficiency of the machinery that exists to enable it to succeed. A good infrastructure (I+) has four main components; a correct definition of needs, correct analysis of the problem, the possibility and appropriateness of the solution, and the reliability and rapid implementation of the innovation. A negative infrastructure (I-), of course, will reverse all these four subcharacteristics.

This description tallies with elements of individual-oriented models. But unlike the latter models, the source of good or negative infrastructure will be difficult to discern from the infrastructural configurations of the model.

The second component of the model synthesized by Havelock and Huberman is Authority, and combines elements of power, authority, control and leadership. The function of Authority is to provide guidance and direction to effecting the change. High Authority (A+) ensures the presence people who ensure a need is recognized, a problem treated, a solution found and implemented.

It is hard to imagine any educational change process without Authority. But at the same time, the presence of Authority in any change situation is not without its own problems. This is because within the context of the model the motivations of the Authority cannot be discerned. It thus becomes difficult to determine when enthusiastic or high authority (A+) is the result of genuine commitment on the part of the authority to see to the attainment of the stated outcomes of the change process, or because cooperation is seen as a political tactic by implementors in relation to those momentarily in control of government structure.

The final component in the model deals with Consensus, and refers to the identification of those involved with implementing the change with the objectives and strategies of any innovation. Consensus, of course, is quite vital to the attainment of the objectives of any innovation. Unless those who are charged with the responsibility of seeing to the implementation of the change share the same sense of purpose as those who initiated the change, it becomes difficult to achieve any measure of success.

Consensus serves as a broad based policing check on the entire change process. This is because unless there is an agreeable degree of Consensus in relation to Authority, progress would not be possible. A certain degree of Consensus also needs to be maintained when decisions about Infrastructure are being made, because unless it is agreed the innovation on agenda is is best realized through the Infrastructure proposed, again progress will be retarded.

These three components of the model are insufficient on their own to explain adequately the change process in education. Their effect must be seen in relation to other factors, although this is determined by the scale of the change being contemplated. Differences in scale refers to the number of people and materials involved in the project. It also refers to expectations of a change in behaviour of some of the people involved with the change - a new behaviour pattern which may differ significantly from existing practice.

The involvement of people, materials as well as expected changes in behaviour yields additional components in connection with, but not integral to, the IAC model. The complexity in terms of people and materials in the change situation is denoted as EL, while expected changes of behaviour is BC. The status of each component indicates the magnitude of its effect on the outcomes of the educational change process. For instance, EL+ signifies a large scale project, while BC+ indicates significant departure from existing behaviour. The pattern of any project, therefore, must be seen in relation to these two final elements.

While the model described by Havelock and Huberman provide a useful framework for analysing the internal structure of the change process, there are still some basic problems when this model is accepted as being perfected. It main flaw is it does not enable judgements to be made regarding the components; whether for instance their status can be judged according to some other criteria, or whether the status of each component described by the model is absolute. For example, an I+ indicates adequate presence of infrastructural facilities. But it is not clear whether such high infrastructure is in relation to other services or localized to particular change instance. The various configurations of the components of the model would therefore appear to describe relative, rather than absolute scales of judgement.

Indeed as Havelock and Huberman acknowledged before presenting the theory of change derived from their model, the educational change process is too broad and complex for all its aspects to be accounted by their model. As such, the model is useful as a framework for looking at information gathered. Moreover, they also admit there was no attempt to test and refine the theory against the information collected. As such, the main usefulness of the model is to predict how future plans for change are likely to turn out. This in turn should allow organization of better planning and implementation of innovations in various local settings.

The discussion so far serves to emphasize the various theoretical categories to which educational changes can be fitted. It therefore provides a general theoretical background against which the pattern of initiation and implementation an innovation such as the Science Schools project of Kano State can be analysed. This should give the project an opportunity of extending our understanding of these theories by testing their universality. It is for this reason that I refrained from deciding at the beginning which specific theoretical model of educational change the Science Schools project can be fitted into because, at this stage of the research, it would be tantamount to pre-empting the data analysis. It is only during the actual analysis when the various characteristics of the project begin to emerge can the project itself be conveniently fitted into any theoretical category, if any. The theoretical implications of the data analysed are discussed at the end of each of the data based chapters, as well as in the conclusion to the thesis.

But from the reviews of the models, it is clear the social process leading to the initiation of educational innovations are too complex to be described by a single model. The review in this section therefore sensitizes the presentation and analysis of the data to the theoretical values of the various stages of the Science Schools project, and attempts are made to link each stage of development with any theoretical antecedent during the data analysis. These theoretical linkages, drawing upon material from this section and the next, are fully discussed in Chapter 9.

2.1.1 Strategies Of Educational Change

The strategies used to implement educational change are no less diverse than the pattern of initiation of the changes. And a review of the strategies provides a clue as to how the various components identified in any change pattern combine to achieve their effect. It will also provide a framework to analyse the actions of significant actors in the Science Schools project.

Whereas a model provides a holistic picture of the change process, a change strategy provides an approach for actually carrying out the change. The decisions to carry out a change carries with it an implicit assumption for the presence of a way the outcomes of such change can be achieved. The strategy may be streamlined according to a particular model, or may be unique to the change strategist.

A survey of the literature concerning educational change suggest three broad strategies of affecting change. The first category centres on the consideration of the rational element in man, and draws its inspiration from empiricist rationalization of any approach. The second involves creation of social situations and contexts where new attitudes and perspectives provide a perfect vehicle for change. The third involves the use of power, or some persuasive technique to affect the change. But as Hewton (1982) argued, the individual approach that predominates in any situation depends very much upon the prevailing social and political context in which the change occurs.

One of the more prominent categorizations of change strategies based on these broad strategies is the one offered initially by Chin, but later modified by Chin and Benne (1969). Their general classification for change assumes three broad categories. The first relates to empirical/rational approaches which involve convincing people by rational means, and appealing to reason and logic using the results of applied and basic research for further conviction.

Rational strategies may emphasize activities that involve communication about the nature of the change, and why it is justified. The various tactics used in this category include education (e.g. in-service training) and information dissemination. Despite these tactics, rational strategies depend on the quality of the change itself to succeed.

The second group are normative/re-educative strategies which involve attempts to affect the values and habits of individuals and groups within the social context. The emphasis is on changing the norm and values which are prevalent within an organization or group by changing the ways in which people relate to each other in the course of their work.

This group essentially involves manipulating some aspect of the change environment so that the change target sees the situation differently (Zaltman et al 1977). Such strategies generally support the change process in many ways, such as the provision of funding for implementing the change.

The third group is power/coercive and is based on the application of power in some form - political or otherwise. The influence process involved is basically that of compliance of those with less power to the general strategy. But often the power applied is legitimate power or authority.

Power strategies are perhaps easiest to apply since they are based on control of reward and punishment, deprivation and restriction which are meaningful to individuals or groups who are important actors in the change process (Zaltman et al 1977). Power tactics used include passing laws to enforce change. But the success of this strategy depends on the extent to which the sources of power are really valued or important.

In another classification of general change strategies, Havelock and Havelock (1973), expanding on Havelock (1969) were also able to synthesize three broad categories of strategies, parts of which bore remarkable similarity to the categories of Chin and Benne (1969).

The first category by Havelock and Havelock (1973) places change as a problem-solving process, which is usually seen as a patterned sequence of activities beginning with a need sensed by those who wish the change, translated into a problem statement and diagnosis. This leads to a search and retrieval of ideas and information which can be used in formulating or selecting the innovation. This further involves the user in adapting, trying out and evaluating the innovation in satisfying the original need. Thus the focus of this change strategy is the needs of the user, and the efforts made to satisfy these needs.

The second category is what they identified as Research, Development and Diffusion. This is quite similar to Chin and Benne's empirical/rational approach. In this category, a product is developed and tested after a period of research concerned with a particular problem. The empirical methodology used for the derivation of this product is expected to be its strongest selling point to those to whom it will be presented for adoption.

The third class of strategies is Social Interaction which relies on the loose association of individuals involved in the change process. This involves the use of informal networks to encourage the flow of information concerning the innovation. The third strategy is Problem Solving, and is similar to Chin and Benne's normative/re-educative approach. The change agent in this case works with a client group within an organization, helping them to identify and diagnose problems and seek out and implement solutions.

Similarly, Zaltman, Florio and Sikorski (1977) also identified strategies broadly classified as empirical rational, manipulative and power strategies. Havelock and Huberman (1977) in their own survey of educational changes also identified similar broad categories although, as they suggested, these categories may become intermixed and produced a more extended classification. Based on this, they were able to identify five approaches.

The first approach was what they called Participative Problem-Solving. This is derived from the trends in the emphasis on the importance of local initiatives, responsibility, and self-help as the driving force of national development. The second, Open Input, is a broad and flexible approach in which attempts are made to make full use of all ideas and resources from both inside and outside of the local community.

The third involves Power as a means of bringing about planned changes, using laws, formal procedures, a chain of command and designated agents for technical assistance. The fourth emphasizes the natural flow of new ideas and products through the social system and between systems. This therefore fall within the category of Diffusion strategies. The fifth and final approach is Planned Linkage, in which the innovation relies on careful planning and specification of clear goals and objectives related to a detailed analysis of the insiders' actual situation.

The review of some of the strategies used to implement changes in education serves the purpose of enabling the identification of the most frequently used implementation pathway, and should provide clues as to the reason for such frequent choices. The various strategies used to implement the Science Schools project are identified within the context of the data analysis, and links are made to the theoretical bases provided by this section.

2.2 Section II: Patterns of Change in Science Education

My focus now shifts to determining the nature of changes in science education through a review of the various projects illustrating an attempt to change science education process and make it more socially and academically accountable. The review focuses on curriculum reform directed at improving the quality of science education, with a concern on the long-range solutions of science teaching problems. And as in Section I, the distinction made between reforms and innovations still maintains its relevance in this section. As Miles (1964) for instance argued,

> "One thinks of reform as involving a large-scale change often involving structural shift with a strong melioristic overtones. Norms and procedures operating in the system prior to the reform are generally seen as bad, undesirable, or morally wrong. If one sticks to the definition offered here, the so-called curriculum reform groups (PSSC and others)...can be seen more clearly as marketers of innovations - and as themselves innovations on a large scale than as purveyors of reform." (Miles 1964 p.14)

What makes science education so susceptible to review and innovations is the widely held belief that economic prosperity can only come through modernization, which, in turn, comes as a result of reliance on science and technological training. As the Committee on Science and Technology in Developing Countries (COSTED) observed,

> "The development of human resources, as important as the development of natural resources, will require proper realistic education. Science can help overcome ignorance, superstition and poverty. Above all, without indigenous science and technology, the resources of a nation cannot be organized for industrial expansion. This leads logically to a consideration of the role of science and technology in education. Scientists and technologists are required in the economic infrastructure of an industrial society, no matter how unsophisticated it may be." (Radhakrishina 1980 p.38)

This is more so in developing countries where the steps towards a modern culture are being contemplated. A review of science curriculum in a way that places prominence on the interpretation of science in social advancement therefore justifies constant curricular reviews. As Rosier (1987) argued,

> "Science is included in the school curriculum for two reasons. First, it has a role in helping students understand their environment and to develop skills in the application of scientific methods to the solution of problems. Second, it provides basic training for those students who will

subsequently follow careers in science and technology." (Rosier, 1987 p.106)

Further, students who were introduced to science in the way envisaged by the science education reform rationales (especially those with roots in the 1960s) are expected to constitute a better class of manpower raw material in science and technology. Such manpower would be in a better position to appreciate, contribute to, and identify with, the modern world of science and technology. Because of this, a prominent feature of the new science curricula in some cases, especially in developing countries, is a reflection of a rationale linked to the labour market in their objectives. Rosier (1987), in a further argument which augment this view, suggested that the inclusion of science in the curriculum

> "reflect common national development strategies that in turn have two strands. One strand requires the population as a whole to have a good understanding of the purposes and scope of science and technology so that the citizens may share as well-informed participants in the process of national development. A second strand is the need for the country to have a sufficiently large group of persons trained in science and technology to help the country in those aspects of its national development that depend on technical competence." (Rosier, 1987 p.106)

Thus a new theme, particularly in developing countries enters the science curriculum reform discussion and that is "science education for relevance and self-reliance." As Bude (1980) observed in explaining the objectives of the Science Education Programme for Africa (SEPA),

> "SEPA chose as a the motto "Education for Self-Reliance" which was instigated by critical reflection on the relevance of education systems in Africa." (Bude 1980 p.34; see also Knamiller, 1984).

This theme is further reflected in a review of recent development plans from African, Asian and Latin American countries, which as Lewin (1984a) analysed, were concerned with social equity and nation-building considerations. The development plans lay a special stress on scientific and technical education. This is more so since all the plans, according to Lewin, assumed links between educational characteristics of the labour force and productivity, even though such links were often generally stated.

The review of various science education innovation projects carried out in this section seeks to determine the lessons taught by the various projects, and in the process, underline the characteristics of innovations in science education. This provides a contextual framework around which the Science Schools can be more effectively understood as belonging to a body of general education change strategies.

Specifically, the review attempts to answer the following four questions: What is the origin of the science education innovation projects? What specific changes were felt to be needed in the way science was being taught which necessitate science curricular reforms? What characteristics did the developers of these projects consider the innovations should have in order to affect these changes? What lessons emerged from the science education innovatory projects? These questions provide four themes around which the review is structured.

2.2.1 Theme One: Origin of Science Education Innovations

A review of the origin of the science curricular innovations provides a clue to their fundamental characteristics, and explores their operational demands. The literature suggests although various countries have different social, economic and political systems, few of the science curriculum reform activities can be said to be endogenous. Most were affected one way or other by similar developments in the United States and Britain which triggered off nation-wide reviews of science curricular contents and teaching methodologies (thus setting unique precedent in an educational revolution without a social revolution as identified by Karabel and Halsey 1977). In most cases, attempts were made to adhere faithfully to the curricular ideals outlined by the general trend of the science curricular reforms. And although the choices for many countries were between adoption and adaptation, invariably a combination of both strategies emerged. In Australia for instance, Dow (1971) was able to identify three approaches to science curriculum development in the country.

> "First, courses have been imported from America and left unaltered although they were designed for different circumstances. The first course to be adopted was PSSC physics in Victoria. Subsequently it was adopted in Queensland. A second example is the CHEM Study course which was introduced into Queensland and Western Australia in a comparable way and is being tried in Tasmania. The other extreme has been to develop new courses ab initio in an individual state to meet local requirements...A third approach, seeking to combine the best of these alternatives, involved the adaptation of American Biology programmes to Australian conditions. A special version of BSCS Biology courses has been introduced into Victoria, South Australia, Queensland, Australia and Tasmania, and the course is being tried in selected schools in New South Wales." (Dow 1971 p.37)

Similarly, even rapidly industrializing nations like Japan, have used the American programmes in their reorganization of the science education curriculum. As Imahori (1980 p.18) stated,

> "power of innovation in science education in Japan was initiated in the 1960's by the introduction of some American projects such as PSSC, Harvard Physics, CBA, CHEMS, BSCS and SMSG...The "process of enquiry" which was emphasized in those projects had a strong impact on Japanese science education. Many Japanese educators and scientists were also quite impressed by the text-books of those projects. As a result, innovative power was initiated in the late 1960's and some science textbooks were reformed imitating the PSSC or BSCS text-books."

The imitating process where the science education programmes of other countries are seen to provide a framework around which developmental objectives can be rationalized is of course not peculiar to Japan alone; it transcends all cultures. For instance, in Lebanon, the American SCIS (Science Curriculum Improvement Study) provided a model for science curriculum renewal in the country in October 1972. In an incidence that was certainly unique, the new science curriculum was adopted for only one private school, the National College of Shweifat. The main rationale for their use was the conviction that

> "whatever the student got from the SCIS course was bound to be better than what they could have gotten from the unpopular course they were following." (Za'rour and Jirmanus 1977 p.409)."

However, it is not in all cases of science curricular reforms in the developing countries that American science courses provided the models. Science curricula from the United Kingdom also provided structural frameworks around which many countries developed their science curriculum. In East Africa, a science project was developed based on Nuffield Chemistry courses in Tanzania, Kenya and Uganda during 1966-1967. According to van Praagh,

> "The courses would be based on modern principles of science teaching with more emphasis on pupil activity and less on rote-learning, and would make use of the Nuffield ideas in construction courses suitable for East African schools. The courses would take account of the children's background, their future careers, the natural resources of the countries, the teachers and the money available. Draft materials were to be written and tried out in a number of schools in each country. The material must be shown to be teachable by existing teachers in their schools and to their pupils." (van Praagh 1971 p.273)

And further down from East Africa, when the Lesotho Introductory Science Improvement Programme (LISIP) was introduced in 1973,

> "the model chosen for this junior secondary integrated science course was the Scottish Integrated Science Course. Although this model was adapted to meet local needs and conditions, the objectives of LISIP, cognitive and affective, were substantially the same as in the parent course." (Towse 1983 p.159)

Similarly, in Malaysia in 1969, the model adopted for the Malaysian Integrated Science Course (MIS) was also the Scottish Integrated Science. And although

> "some adaptation took place, the bulk of the course material and recommended teaching strategies remained unchanged. Indeed, MIS materials refer teachers to the Scottish Integrated Science publications for further advice and guidance." (Lewin 1980 p.34; see also Jeffrey 1971; but for a more detailed study which looks at the issues of trans-cultural curriculum adaptation, see Lewin 1981)

Interestingly, while in Malaysia the junior secondary schools adapted the Scottish Integrated Science curriculum (from Scotland), the upper secondary schools in the country used an adaptation of the Nuffield Foundation Science Teaching Project materials, especially the Biology, Chemistry and Physics Projects (Tan 1979).

The persistent use of science educational models from developed countries as a basis for the new reorganization of the role of science in social transformation in developing countries is often justified by the contention that the benefits of science are not culture specific. According to an argument,

> "Modification is not drastic in the subject matter of Chemistry and Physics programs for international use as they are largely of international constants. Chemical reactions are the same in North America as in Australia, and the principle of the lever is the same in India as it is in Italy." (in Maddock 1981a p.4).

And while the initiators of the original programmes and courses may feel assured their ideas are taking root in all cultures, the developers of the BSCS, for instance, could
not help cautioning that,

> "while some of the BSCS materials are suitable for use outside the United States, the versions of BSCS Biology were prepared with students in the temperate zones of North America in mind, and they are not considered suitable for use in overseas countries without adaptation." (Maddock 1981a p.4)

A similar caution was also voiced where Nuffield Foundation Science Teaching Projects of the United Kingdom were adapted in developing countries. As van Praagh (1971) observed in considering the appropriateness of the Nuffield Chemistry course in developing countries,

> "In considering further the appropriateness of the courses, we must remember a number of factors in which differences of varying degree exist. These include the background of the children, their futures after taking the Certificate, the teachers who will teach them, the facilities for science teaching in schools, the amount of money available, etc. All these were factors we had to take into account when thinking about and working out the Nuffield material. The general objectives are the same but a certain amount of modification is needed in working a suitable scheme." (van Praagh, 1971 p.270 and 272).

The direct transplantation of the curricular ideas across cultures was not without consequences. In Japan for instance, Imahori analysed that,

> "The first point was that it led to the teaching of more difficult and larger quantities of knowledge. This tendency was accelerated year after year by the peculiar entrance examination system of this country. The difficult and voluminous knowledge was required to be tested in the examination but it did produce many stragglers and pupils with hatred of science. Another point to be emphasized is that laboratory work came to be neglected in science education and the process of enquiry was taught occasionally using a dry laboratory ("enquiry" only by using scientific data shown in texts)" (Imahori 1980 p.18)

However, as was to become a pattern in cases of either adaptation or adoption (and the distinction in most cases proves increasingly difficult to make), fundamental issues such as appropriateness of the newly acquired science curricula were masked by rhetoric. As UNESCO reported in a case study of the Malaysian science curricular reforms,

> "The science curriculum innovations, with their inquiry-based activity-oriented approaches to the teaching/learning science, have given rise to some problems. One is the concern for the effective implementation of this inquiry-based teaching. Other problem areas include lack of apparatus, an important component in this activity mode of teaching/learning science, and the concern for the effectiveness of in-service education." (UNESCO 1984 p.163).

Further, enthusiasm about the newly adapted science course, tend to override practical considerations, especially those to do with the set of circumstances in the various schooling systems. This is seen, for instance, in the SCIS adoption in Lebanon where,

> "As to be expected, many problems were faced in the implementation of a program roughly half way around the world from its birth place, especially as there was no assistance from project personnel and the school began teaching the courses without all the prepared materials and apparatus." (Za'rour and Jirmanus p.410)

Similar problems were encountered in many other places where the developmental ideals suggested by the American and British science educational strategies were used as summarized plans for social transformation in developing countries. As Reay (1977) observed about the introduction of the American Physical Science Study Committee Physics curriculum,

> "India introduced the PSSC without ensuring that certain conditions were satisfied (such as motivated and re-oriented teachers) and without considering local circumstances. The advance on earlier teaching was too great and PSSC did not survive as such in India, although some parts of the package are still used, such as the locally manufactured kits of apparatus and the films." (Reay 1977 p.143)

The use of science curricular from other, more developed, countries certainly has an advantage. For instance, it provides an instant set of ideas, rationale and materials which some countries cannot produce immediately because of the lack of appropriately trained personnel. This indeed seems to be the case in developing countries just freed from colonial domination. Such transfer also provides models of new courses which could be used in the training of future curriculum developers.

The transfer also has some disadvantages, not the least of which a nation's needs are not always catered for in the transferred curricula. Further, the cultural mode, i.e. the linguistic, social and ideological references of transferred curricula did not always match that of the user country. This does tend to create an unusual political situation in developing countries. For instance, having fought hard to regain political freedom from colonial administration, it is interesting to note many developing countries still relied on former colonial rulers for curricular inspiration in science education. For instance, the Science Education Programme for Africa (SEPA) was started after independence in many African countries when

> "Dedicated American and European scientists, curriculum developers and science educators began a gigantic curriculum reform in Africa." (Alabi 1980 p.140)

Their efforts eventually led to the premier contemporary science curriculum project for Africa in the form of African Primary Science Programme which later became Science Education Programme for Africa.

And as was to become characteristic of science curricular innovational changes, more often than not, the impetus for the change comes from asmall professional group who have the political influence to make their views heard in their respective political hierarchies. As Lewis and Winter (1972) analysed,

> "Concern for revision of existing science-teaching programmes usually develops from one of the four groups. Officials in a ministry of education may wish to introduce into the schools of the nation some of the ideas produced by world-wide science-curriculum reform movement. It may be the scientists of the nation...who find that school programmes have failed to keep pace with the rapid changes in the sciences and are in need of modern ideas. It may be officials in a national planning office who find that the goals set for social and economic development place demands on the schools for scientifically and technically trained manpower in excess of the schools' capability to produce it. Finally it may be the teachers themselves who are conscious that what they are teaching is outmoded, that their techniques are inefficient or inadequate to produce children who will think for themselves and are properly equipped for the society in which they are growing up." (Lewis and Winter 1972 p.234)

Thus despite education being the sole social responsibility of the central government, it is not in all cases that the science curriculum reform, though with strong social and political pay-off, became the result of government initiative. In England, for instance, the initiation of the Nuffield Foundation Science Teaching Projects was the direct result of professional science teacher pressure groups, rather than government's concern with the quality of science education taught to British children (see also Waring 1979).

In other situations, nationalistic fervour serves as the main impetus in the development of newer science curricula, even though there does not appear to be much difference between the newer localized curricula and older adapted science curricula. In Australia, for instance, the US science curricula provided a basis for a reappraisal process, and were indeed even adopted in some states. But the Australians soon realized that the only solution to revolutionizing Australian science education lies in developing a science education programme which can be considered truly Australian. This view was the genesis of the Australian Science Education Project (ASEP) which was sponsored by the Australian government. And

> "Unlike American projects of the previous decade, there will be no attempt to develop a uniform, carefully structured and sequential course. In view of the different requirements of the states, the project will concentrate upon the preparation of instructional materials which can be used by students and teachers, and adapted to different courses. The

> materials will not interlock so tightly as to make it necessary to use the entire series in any one course." (Dow 1971 p.61. See also Lucas 1972, and Fraser 1978)

The Australian approach thus reflects attempts to shift away from package deal objectives of the American science curriculum to developing what would appear to be a science course that reflects the realities of Austrian life.

Similarly, the Malawian science education reform began when the country decided to drop the Cambridge overseas examinations system and devise one of their own in 1969. As a first step towards a full indigenization of the science curriculum, a committee made of up of equal number of expatriate (mainly British) and local Biology teachers

> "was set up in 1969 and given a brief to produce a Biology syllabus complete with detailed instructional objectives and an examination structure based on the syllabus which was fully relevant to the local environment and which was relevant to the needs and development of the country." (Moss 1974 p.20)

While the committee deliberated over the sequence and structure of the topics to be included it was agreed that the main task

> "was to consider which topics taught in conventional biology courses could be deleted in the interests of introducing essential concepts and matters of practical interest and relevance. In this exercise, we were confronted with a welter of learned articles and with various "modern" courses such as the Nuffield, BSCS and SSP (East African)." (Moss 1974 p.21)

Out of this "welter of articles" a Biology course eventually emerged which not only laid emphasis on acquisition of knowledge and understanding, but also stressed on the appropriate attitudes, interests and practical skills of pupils. Moreover,

> "whereas the course must aim at preparing pupils for tertiary education, it must be complete in itself and not be thought of as merely an academic exercise or an unrelated rigorous discipline." (Moss 1974 p.21)

It is interesting to note that the Malawian Biology reform effort was aimed at satisfying two different types of students: those who will continue their education and those for whom the secondary education is the highest formal education they are likely to have. This reflects attempts to make the maximum use of limited educational facilities, although how this is eventually achieved is often not fully explored, especially since the needs of these two groups of students are totally different.

This theme has indicated that science curriculum reform is a direct inspiration of similar developmental strategies in America and Britain. It has also highlighted some of the problems to be faced when distinctions are not made between the ideals of such curricula and their operational realities in developing countries.

2.2.2 Theme Two: Identification of the need for a change

What must have been of interest to the change analyst is the mechanism through which the needs for the new science curricula were identified. In the United States, for instance, the first generation of science curricular reforms were initiated by a wounded pride after the launching of the Sputnik by the Russians in 1957 (Yager 1981 p.1).

The consistent primary motive for considering the changes in developing countries is dissatisfaction with prevailing curricula. In many developing countries, new political independence has brought in new priorities which it was felt could not be met by former colonial curricula. As Alabi (1980) explained,

> "With many African countries becoming independent, the Ministers of Education began to call for Educational Reform in education generally so as to make education directly related to the newly acquired independent status of African states. They stressed among other things, relevance, quality and large turnover of trained personnel." (p.140)

A refined illustration of this new ethos is reflected in the rationale of Nigeria's Aiyetoro Basic Science Programme developed in 1962 which states,

> "In the past, science had been taught in an authoritarian, verbalistic manner in Nigerian secondary schools. The objective of this project was to produce materials, centred around the process of science, which would teach pupils to accept the evidence of their own senses rather than to rely on authority in the person of the teacher or the book and to engage in independent, critical thinking. Nigeria was just emerging from its colonial past, and it was felt that a science programme of this sort would contribute much toward producing citizens who could participate in a democracy" (in Lockard 1970, p. 203)

A similar analysis of antecedent schooling conditions was made in other developing countries; and associated with the analysis is often a curricular solution borrowing precedent from science curricular reform in either United States or England. For instance, in Thailand, it was observed

> "The nation wide chemistry curriculum at the upper secondary school level prior to 1976...had been very traditional in comparison to many other countries. Theoretical chemistry and laboratory chemistry were taught separately with little relationship between them. Laboratory was not a required part of the course. Some topics were out of date; others such as calculations and descriptive chemistry were presented in too much detail...Teaching strategies emphasizing memorization were based entirely upon a teacher's teaching rather than a student's learning. Teachers were not familiar with investigative inquiry teaching techniques...High level questions were seldom asked. Students were not encouraged to ask questions, think, present ideas, or participate in class discussions." (Sapianchai and Chewpreccha 1984 p.44)

Consistent criticism of these approaches in Thailand's secondary schools led to the establishment of the Institute for the Promotion of Teaching Science and Technology (IPST) in 1972 which was a cooperative venture involving both the

Thai Royal Government, the United Nations Development Programme (UNDP), and the UNESCO. The main objective of the IPST was to

> "develop modern science and mathematics curricula at every level below the University." (Sapianchai and Chewpreccha 1984 p.44)

In other cases of American influence, a close parallel developed between those advocating for a revolutionizing the science education process in their countries and how it was started in the United States. This is illustrated by Argentina where the scientific community, as was the case in the United States (Baez 1971), pressed first for changes in the country's science education system. As Maybury (1975) reported,

> "Early in 1960, an elite corps of Argentina's scientists, associated as the National Council for Scientific and Technical Research took stock of the outdated and inadequate science teaching in the schools of their country and ...saw that inadequate science instruction at the secondary school level was holding back the development of high-level scientific manpower in Argentina. They saw the flaws in that instruction: its dependence on rote memorization of formulas and facts; the outdated textbooks and lack of teaching aids; little or no opportunity for students to carry out laboratory work; poorly trained teachers with neither the time nor the incentive to keep abreast of new developments in their subjects; student-teacher contact limited to the lecture room..."(Maybury 1975 p.1)

A solution to these problems was seen in the establishment of a venture aimed at improving secondary school education by the Council, which started with a seminar for 35 Physics teachers in 1961. The success of the seminar resulted in the Council requesting - and receiving - further funding from the Ford Foundation, and this served as a basis for subsequent science curriculum reform in the country. The first generation American science curriculum materials, especially the BSCS, CHEMStudy and PSSC were adapted and translated into Spanish. It is interesting to note here that the impetus for the change came from the scientists in the country, rather than the science teachers themselves, or as identified by Lewis and Winters (1972), government officials.

But using the weaknesses of the prevailing science curricular as the main basis for the development of a rationale for new science curriculum project was not restricted to developing countries alone. In Holland,

> "American programs like 'Chemstudy', English programs like Nuffield, and Scottish programs like 'Chemistry Takes Shape' have had their influence on chemistry teachers in Holland. Many teachers expressed complaints about the existing curricula. These complaints were focused on the first year of chemistry at the secondary school." (Hondebrink 1981 p.963)

The criticisms were especially aimed with the view that the existing curricular provisions in science education (although with emphasis on Chemistry Education) in Holland were

> "not attuned to pupils who would not continue with this subject. The consequences were that, for the majority of pupils, chemistry was perceived as difficult and seemingly useless. In later life, they hardly remember anything about it...There was also complaints about the choice of topics presented and lack of time to do lab work. Chemistry was usually taught on very theoretical basis, hardly connected to real experience." (Hondebrink 1981 p.963)

These observations led to the setting up of the Committee for the Modernization of Chemistry Curricula (CMLS) which was financed by the Ministry of Education. The result was the production of new curricula and textbooks in science, aimed at making the new curricula "practically applicable."

The attempts to link science curriculum reform with labour market also made appearances in some projects and became linked with a concern aimed at production of scientifically literate labour force. And at secondary school level in many developing countries, any labour market orientation of the school curricula is more readily identifiable with vocational labour force, rather than highly trained scientific and technological manpower more associated with advanced training in science which has its basis in secondary science curriculum. As King (1982) argued in considering science education in East Africa,

> "The new interest in asking about the impact of science on work and society is likely to be very different question from those asked of vocational students. For one thing, there is interest in the transformational potential of science. Not just whether students have ended up in vocational jobs, but whether they are using their science to apply and to modify their environment." (King 1982 p.12)

An illustration of attempts to orient the science curriculum towards a labour market requirements is see in Jamaica where the Grade 10 and 11 science curriculum innovation evolved

> "in response to the need to prepare 15-year olds for the job market (and keep them off the streets). The response came in the force of the Prime Minister's announcement in his Budget speech, in May 1973 when he declared that all 15 year olds in junior secondary schools should remain at school for two more years. This was to take effect in September the following year. This placed 17,000 students in Grade 10 in each of the succeeding years 1974, 1975 and 1976. The programme was to be primarily vocational, thus shifting the focus of secondary education away from the Cambridge Overseas Examination. The method was to be essentially self-instructional. Assessment was to be continuous. In all respects new ground was being broken." (Commissiong 1979 p.87)

The concern therefore about the inadequacy of the existing science curricula to enable students to contribute to social development has given rise to rapid reappraisal of such practises and led to new strategies. The most predominant concern - linked with political sentiments - emerged in the United States and gave rise to the initial wave of science curricula reforms. This movement rapidly found itself in developing countries, and the initial rationale of such curricula reforms in the US mutated to social manifestos. Suddenly, the same science which has been taught for decades has, overnight, become irrelevant and inadequate in solving social problems. Science curricula from more developed countries were adopted, or adapted as providing adequate means of social transformation. The next theme explores their individual characteristics.

2.2.3 Theme Three: Characteristics of the Innovations

However, in considering curricular revisions in science education, there is a need to make a distinction between "innovations" and "renovations." This should provide a proper judgemental climate in deciding the characteristics of the science curricular innovations. In an observation of the science curricular trends, Tish et al (1972) argued,

> "the last two decades have been characterized by the development of numerous science curricula, for example, PSSC (Physical Science Study Committee), ASEP (Australian Science Education Project), CBA (Chemical Bond Approach), BSCS
> (Biological Sciences Curriculum Study)...to name but a few. Each one is supposed to contribute something new and vital to science education, and in particular, to foster greater understanding of and liking for science. But is this the case? Do they, for example, actually contribute something new and vital to science education?" (Tish et al 1972 p.20)

Nevertheless, the force with which the first wave of science curricular reform activities swept the world has far reaching effects in the interpretation of the role of science in social advancement.

The intentions and likely effects and outcomes of these reforms for African countries were clearly stated in the project brief of the African Primary Science Program. This was started in Kano, Northern Nigeria in February 1965 by American advisers with major funding from the Ford Foundation. The stated objective of the APSP was

> "to determine to what extent new ideas and methods for teaching science, particularly the so-called "discovery" method developing in the United States, United Kingdom and elsewhere are applicable to Africa. Specifically in Sierra Leone, Liberia, Ghana, Nigeria, Kenya, Tanzania, Uganda, Malawi, Zambia and Lesotho" (in Lockard, 1967, p.5)

Five years later, in 1970, representatives from nine Anglophone countries in Africa assembled in Freetown, Sierra Leone and renamed the APSP Science Education Programme for Africa, SEPA. Its motto became "Education for Self-Reliance" and it became an umbrella organization for the development of science education programmes in Africa.

But developing a science curriculum was not the only objective of the SEPA. As Yoloye and Bajah (1980 p.178) explained, the APSP/SEPA philosophy was guided by the belief that

> "Science is an activity carried out by scientists. As a result, any modification to the approaches used in schools which were already found wanting was to be taken by scientists...The APSP approach was summarized as child-centred flexible, unstructured, open ended.

> Science, the architects of the APSP approach maintained, should be taught in the way scientists operate. If APSP was to make any noticeable impact on the African educational scene, it must revolutionize science teaching and not just provide a subtle approach conforming with what already exists, they claimed."

In cases where specific action is thought necessary, the science curriculum reform strategy usually begins with individual science subjects. In the Federal Republic of Germany, for instance, the focus of the reforms was Physics where efforts were concentrated in the development of physics education for school years 5 and 6 (11 to 12 year olds), and for years 9 and 10 (15 to 16 year olds) in the German educational system. The new programmes were devised and published by the Institut fur die Pedagogik der Naturwissenschaften (IPN) at Kiel University. The emphasis of the IPN courses was 'science in society'. According to Millar (1981 p.37),

> "The treatment of the topics in their context and their complex relation to problem areas...should be a component of physics instruction. For this supplies the basis for deciding why and how physics teaching should take place, and why the subject physics should remain part of the school curriculum."

In the event, it became possible for the IPN - which was established in 1966 after the first wave of the science curriculum reform movements - to devise new science curriculum materials for various parts of the secondary school because it is the only major science curriculum centre in Germany. The IPN indeed virtually re-wrote the entire curricula of the three major sciences, not just Physics, for much of the secondary school years in the country. However,

> "there is no official mechanism in Germany for encouraging schools to adopt particular courses or teaching styles. Consequently, the IPN courses must compete for adoption in the 'open market'" (Millar 1981 p.25)

This situation illustrates a clear division between an academic perception of the role of the newer science curricula and government educational legislation, because it was apparent unless some legislative mechanism is available to place the newer science courses in the educational system, their long term benefits may not be realized (see, for instance, Adams and Chen 1981, for an exploration of the interface between administrators and researchers in implementing educational innovations).

In other cases of science curriculum reform, a science curriculum emerges with a definite vocational zeal, although a careful analysis of the stated intentions of the curriculum often yields statements of objectives owing their characteristics to tertiary level scientific aspiration than immediate labour market absorption of students. The Grade 10 and 11 Programme of Jamaica has this particular characteristic where, it is stated, for instance

> "To meet (its) aims the programme is being revised as part of the Core Curriculum in Science. The existing programme for Grades 7-9 aims at developing a functional course which should enable the average citizen to understand and interpret the world of science. It emphasizes practical

skills and thinking skills which are geared to helping students solve problems. This programme, in addition to identifying skills and attitudes, describes more clearly the science content." (Commissiong 1979 p.90)

As was a pattern in both developing and developed countries, the strongest rationale of science curriculum reform in Jamaica, from academic perspectives, was the view that the prevailing system was inadequate in providing school leavers with the desired intellectual characteristics necessary to modern nationhood. In Jamaica, the newly produced science curriculum has the following characteristic:

> "The intent of the Core Curriculum Units is to shift the emphasis further from science as a body of knowledge to science as a method of enquiry. Prior to the development of a core curriculum, science was presented with the emphasis reversed." (Commissiong 1979 p.90)

The Grade 10-11 Programme started as a project in 1974 although it became fully incorporated into the regular instructional system only in 1978. And while it was formally assessed by individual researchers at the University of West Indies, the full impact of the project on the labour market was not revealed; consequently, it becomes difficult to make judgements about the extent to which the labour market values students who finish the course.

Similar approaches of identification of lack of social relevance apparently inherent in the older science curricula were also expressed in Asia, and characterize the emergent new science curriculum. This was seen for instance, at the Regional Meeting of the Singapore National Commission for UNESCO held 20-26 July 1976 when the Meeting observed,

> "Although a traditional approach to teaching science as a body of facts (knowledge) is still prevalent, and in some countries, with heavy emphasis on teaching 'pure' science principles first and foremost, there is now a noticeable shift in a number of countries, particularly in their new programmes. This shift is from the closely-directed learning of established facts to conceptual understanding and to applications of acquired knowledge and skills to life problems. There is a greater stress on first-hand experiences by pupils and their active involvement in the learning process through enquiry and discovery, and on the application of science while incorporating elements of technology." (UNESCO 1976 p.6)

Other characteristic features of the science curricula reform emphasized institutional arrangements where the quality of science teaching and learning are both effectively improved. Often the new institutions become the centres of either local or national science curriculum reform. This is illustrated by the establishment and development of The Phillipines Science Teaching Center which was established in 1964 as part of the University of the Phillipines[2].

Eventually the centre became a focus of wide-scale science curricular reforms in the Phillipines and one of its first tasks was "to adapt the US Biological Sciences Curriculum Study (BSCS) material for use in the Phillipines." (Maddock

[2]. The Center was renamed Institute for Science and Mathematics Education on 6th October 1983.

1981b p.254) In 1969, a meeting of Phillipine educators led to the formation of the Science Education Project of the Phillipines,

> "which set as its goal to make education in science and mathematics more relevant to local needs, to concentrate on needed skills, to improve in-service training for science and mathematics teachers, to develop and produce a new series of science and mathematics textbooks for local use, and to set up a continuous evaluation of, and encourage research into, science education." (Maddock 1981b p.254)

The project has received assistance from UNICEF, UNESCO, the American Peace Corps, and the American Ford Foundation, and the The Phillipines Science Teaching Center became its main co-ordinating centre (Maybury 1975).

But while the focus of the science curriculum reform, especially in developing countries has always been on the subjects, only few countries emphasized other aspects of schooling such as getting the required teachers to teach the new science subjects, especially in the way envisaged.

The major assumption would seem to lie in the hope that science teachers will identify with the new techniques of teaching science. This assumption would only be valid if the teachers themselves were part of the process leading to the development of the new science curriculum, which, if anything, ensures some measure of long-term commitment from them to teaching science the way they agreed it should be taught to students. But in most developing countries, the conditions of teaching are such that no curriculum developer can hope to rely on teachers remaining in the system long enough to sustain the ideals of the new science education initiative. A permanent solution to properly oriented teacher supply then has to be found, and facilities for successive production must be created. This was the main characteristic of the Kenyan science innovation strategy.

The Kenya Science Teachers College, KSTC, was a cooperative venture between the government of Kenya and the Swedish Agency for International Assistance (NIB). The request for the establishment of the KSTC was made by the Kenyan government on 31 December 1961. At the time of the request, there were 265 science teachers in secondary schools in Kenya. Of these only 60 or so were local teachers (Gumo and Kann, 1982). The request was approved on 6 May 1965 and the College was officially opened in 1968. Right from the beginning, the coordination of the College was through both the Swedish International Development Authority (SIDA) and the University of Uppsala whereby the main part of the responsibility for the project was delegated to the university. The KSTC project

> "was a blend of academic study and professional training. Over three years a student spent about two thirds of his time carrying two subjects to the equivalent of Higher School Certificate level and the remainder in a combination of educational theory and teaching practice...KSTC was not only concerned with quantitative production of S1 teachers but also in the production of good quality teachers capable of using methods of teaching science." (Gumo and Kann 1982 p.18)

Yet the first flaw of the KSTC was lack of a specified focus of science curriculum activity with definitive philosophy. The KSTC graduates were expected to teach science in secondary schools. But the nature of the science in the secondary schools was not detailed. The situation was not helped by the fact that the initial curriculum development for the KSTC took place at the University of Uppsala. Or that as a first step,

> "the Swedish tutors and lecturers had to familiarize themselves with the British secondary school system which was the predominant one in Kenya at the time." (Gumo and Kann 1982 p.19)

Thus the development of the KSTC was not accompanied by a corresponding curricular change or reform in Kenyan science education. The KSTC became an innovation in science education only in that it enabled a long term replacement of the expatriate science teachers in Kenya with local teachers in the lower classes of the secondary schools (university graduates are taken to higher classes). However, there would appear to be a problem even in this. According to a preliminary evaluation of the KSTC done by Linne in 1970-71,

> "it was noted that 63 per cent of the graduates had indicated that they would in future, given the opportunity, like to change their occupation, and only 5 per cent indicated a wish to stay in the profession." (in Gumo and Kann p.30)

In other situations, the science curriculum reform was approached from the perspective of creating new science learning contexts in the form of high schools which differ radically from the existing conventional schooling process. These schools become a long term investment in ensuring a supply of science graduates from the secondary schools. One of the earlier cases of this was in Turkey, where the Ford Foundation substantially financed the development and establishment of a Science Lycee in 1964. The Lycee was to cater for high ability children with aptitude for science education. As the Turkish Minister of Education explained in introducing the Lycee in February 1962,

> "As for our country, I find it suitable to found a High School of Science where students with high ability could be boarded without charge or to modify one of our present high schools into such a High School of Science. This High School should train the staff for our future scientific program and the graduates of such a high school should further their education in the fields where they are most gifted. The High School of Science will be mainly interested in the teaching of Mathematics, Physics, Chemistry and Biology, Social Sciences and Turkish. I don't think that this school for the gifted who seem to be apart from the mass or the country would be anti-democratic in any respect." (in Maybury 1974 p.112)

Similarly, one of the Malaysian strategies of long term science education reform involved the government setting up specialist science schools. As a Malaysian government plan explained,

> "One important feature of the upper secondary education was the establishment of fully residential science schools, with a total enrollment capacity of 9,200 to provide expanded educational opportunities for

pupils from rural areas. Ten of the schools have been completed, while one is expected to be completed by 1977." (Malaysia 1976 p.386)

One interesting feature of this is the apparent emphasis on rural population. In all the cases of science education reforms presented here, the specific beneficiaries have never been delineated; although there is the assumption that all secondary school students, regardless of background and status in the society are to benefit from training in science. But because of the proximity of urban schools to the centre of governmental control, attention tends to be invariably focused on them.

A further aspect of the assumptions about the science curriculum reform relates to the resource demands made by the new techniques. But it is only in few cases, especially in developing countries that resources were placed high priority before the production of the science curricula was even started. This was the strategy adopted in Brazil as early as 1954.

The science curriculum reform efforts in Brazil began with an intensive production of workshop materials and science kits - before the issues of the nature and direction of the science curriculum (whether new or old) were even deliberated. The production of the science kits was so successful that it became a full fledged commercial activity, based at the Brazilian Institute for Education, Science and Culture, IBECC in 1954. The sole purpose was to provide secondary schools in Brazil with inexpensive and pedagogically sound apparatus in Biology, Chemistry and Physics in order to encourage teachers and especially students to experiment with scientific ideas both at home and school. By 1960, over 2000 Brazilian schools were provided with equipments produced by the IBECC (renamed later to Brazilian Foundation for Science Education Development, FUNBEC).

When the Brazilian project assumed national proportions, the Ford Foundation moved in with offers of financial help in January 1961. At this stage the first generation of American science curriculum text materials were translated and introduced in Brazilian secondary schools. By the end of 1970, the American materials were fully translated and distributed to all the schools in Brazil (Maybury 1974).

In this case it was quite easy for the schools to adopt the American courses, at least as far as the resources were concerned, since the first strategy had ensured a massive distribution of science equipments to all the schools before the curricula arrived. This was followed by an intensive retraining of science teachers, and between 1961 to 1964 about 1800 science teachers have been retained in the new science courses at FUNBEC. In 1971, a Law was decreed in Brazil making it compulsory for all the secondary schools to adopt the new science courses.

Thus far my review has concentrated on tracing trends and developments in developing and developed countries. However, science education efforts in East European countries are no less interesting in their motives than in other parts of the world. Unfortunately, information about rationales for such science education reforms, when separated from party ideological overtones, tend to be too terse to reveal any information on patterns or characteristics for science curricular reform[3].

For instance, in discussing Mongolian science education reform, UNESCO reported:

> "In 1971, all educational establishments introduced new curricula and the Ministry of People's Education adopted a new curriculum for general educational secondary schools. In 1979, this plan was further improved by introducing some amendments. There is no fixed time for amending curricula." (UNESCO 1984 p.179)

However, the context and rationale of such changes were not revealed; nor even the nature of the new curricula. But from all indications, while the thrust of what science education can offer for the learner remain truly universal regardless of political or social ideology, the strategies of achieving this in the Eastern block countries are significantly different from those used in Europe and North America. As Baez (1976 p.87) noted,

> "...from data available to Unesco (it can be concluded) that in the U.S.S.R., and probably all of the Eastern European countries, there was not a sudden massive surge of activity in curriculum reform and course content improvement in science as there was in the West during the 1960s but rather a continuous improvement that took place and continues to take place through the agency of the Academies of Pedagogical Sciences...They achieved improvement by exposing all pre-university students to courses in the basic sciences and mathematics throughout many of their high school and even pre-high school years. In this way they built up a massive reservoir of students with scientific knowledge. The very best students among them must have reached a high enough level of achievement in science to do well subsequently in the university and at the technological institutes."

The belief in the power of science, through science education, to reduce the magnitude of already existing social and educational problems thus became formalized through massive science curricular reforms which became a single universal anthem cutting across all racial, social and ideological barriers. The image of science education as powerful agency for social, indeed universalist human transformation - making humanity one big happy family - has never been made more evident.

2.2.4 Theme Four: The issues raised by the Science Education Reforms

However, it was not long before a disquietening feeling started to develop among the science education community across the world about the science curricular activities. Rapid changes in social, economic and political affairs in virtually all countries from the mid 1960s to mid 1970s brought with them new perspectives on the use of scientific knowledge in human affairs. Questions

[3]. However, further case studies of science education in Eastern block countries, especially in the Soviet Union can be found in two 1977 issues of Soviet Education (January and June) which devoted many articles by Russians about science education in the Union. Of special interest are articles by Buravikhin (1977), Volkov (1977), Razumovskii et al (1977), and Gloriozov and Ryss (1977).

begun to be asked about what the science curricular reforms actually set out to do and what they ended up doing.

The issues raised by the science curricular reforms reflect a new trend in humanistic perception of the role of science in social affairs, and government accountability. In the United States, the various political and social changes of the 1960s and 1970s - the same forces that led to the initial science curricula reforms at the beginning of the 1960s - created deep feeling of uncertainty about the future of science education. The direct consequence of these changes were in the area of public and significantly, Congressional support for science education. As Yager (1981 p.2) explained,

> "Individuals and organizations (many of them fundamentalist groups) attacked some of the old (e.g. MACOS) and most of the new (science) curriculum efforts as "unAmerican", inappropriate, and even pornographic. These concerns caused a major reassesment of policies, directions and support for science education activities. During the mid 1970's work on curriculum development was curtailed; active projects were scaled down and few new ones were initiated."

The direct consequence of this development is the setting up of many evaluative projects by the National Science Foundation. One of them, co-directed by Stake and Easly (1978) has the main objective of collecting information which describes the status of pre-college science education in the US in 1976 to determine its future direction. Another was Project Synthesis whose main purpose was

> "to assemble information that would provide a picture of K-12 science education. An attempt was to be made to assess the impact of public support for science education during the past twenty years. Were the improved courses and the support for teacher education successful? Had science education kept pace with science, society, knowledge and schooling?" (Yager 1981 p.2)

Many aspects of science education were assessed in the light of important educational goals, student capabilities and limitations, and forces at work within educational systems. The assessment by Project Synthesis

> "revealed a growing mismatch between the practice of science education and the needs of individual students and our democratic society. The basic problem is that the educational goals reflected by practice in science education appeared to be extremely narrow, and based on the erroneous assumption that most science students will go on to take considerable coursework leading to careers in science. Goals which appear to be largely ignored include preparation for citizen participation in science and technology related-related societal issues, preparation to utilize science in everyday life, and preparation for making career choices in science-related fields." (Kahl and Harms 1981 p.113.)[4]

[4]. For further critical commentaries of the science curriculum reform movement in the United States in the late 1970s, see Helgeson et al (1977), Jackson (1983), and Laserson et al (1984).

In England, the Association for Science Education (ASE) has established itself as one of the most authoritative and constant critics of British science education. The Association, indeed, did play a very significant role in the proposals that led to the establishment of the Nuffield Foundation Science Teaching Projects in England in the 1960s (Waring 1981). However, in a further critique of general, but more particularly science, education in the United Kingdom in 1970s, the Association noted,

> "Education, and its general expansion, was seen both as a social and economic "good" directed to both qualitative and quantitative ends. Since the mid-1960s these assumptions have been either questioned or proved false, such that it is now widely recognized that education does not have a direct influence on the economic prosperity of the country...Society has been slowly and perhaps painfully, coming to the conclusion that improved educational provision does not in itself lead to social change and that science by itself cannot solve all problems. This has resulted in a crisis of confidence in the effectiveness of our educational system and a strongly overt pressure for greater accountability." (ASE 1979 p.20)

And while reiterating the influence of the Nuffield courses which stressed the illustrative nature of the course content with the hope that teachers will adapt them for their purposes, the Association further observed,

> "a combination of the examination system, parental pressure, professional inertia and commercial interests, has led to a second generation of teaching schemes which remain highly codified. Secondary school science is still firmly characterized as being fixed and non-negotiable in contrast to many other areas of the curriculum." (ASE 1979 p.23)

Thus "what began as an attempt to provide continuous renewal and flexibility in the teaching of science has often emerged as a new orthodoxy." (ASE 1979 p.27)

And while the ASE suggested consultative curricular alternatives in science education which were based on a consideration of science for all children with emphasis on the nature and philosophy of science, one of the concrete pay offs (and there were quite a few) of these observations was a joint venture between the Association and the Schools Council leading to the Secondary Science Curriculum Review (SSCR) with a concern "in exploring the strengths and weakness of a range of alternative definitions of secondary school science." (West 1982 p.67). As the information brief for the Review of the Secondary Science Curriculum stated,

> "The unsatisfactory nature of science education in secondary schools has been emphasized recently in various publications. This review has been set up to look at the aims of secondary science education and, in the long term, develop a system of science courses that can be taken by all pupils, regardless of ability so that all receive some grounding in science. The project team are particularly concerned about the disproportionate number of boys and girls who study science. They will also consider the place of technology in science course and look at

ways of making pupils more aware of the cultural and social implications of science."[5]

And although in Canada, like in Japan, Holland and Australia, the American science curriculum projects provided models for the development of Canadian science education in the late 1960s, it was not long before a crisis of confidence in the adopted science curricula developed. In 1972, a research team was formed at the Universite de Montreal for the purpose of evaluating science teaching, mainly at the end of the secondary schools. At that time,

> "The majority of the programs and methods used in science teaching were adaptations of American products of the 1960s. Furthermore, regardless of the textbooks used, the teaching and learning of science were presenting serious difficulties for teachers and students." (Ste-Marie 1982 p.10)

The team discovered not only a general decline in interest of the students in all science subjects over the course of the year (and the more science courses the student took, the sharper the drop in interest), but was able to conclude

> "The teaching of science did not in general contribute to students' emotional development. Motivation to study and satisfaction with the course remained low. We noted that this aspect could be improved by presenting materials oriented towards the individual." (Ste.Marie 1982 p.17)

These observations opened a floodgate of further criticisms of the role of science education in the Canadian society. In particular, the discussions of Page (1979), Aikenhead (1980), George (1981), Munby (1982), and Roberts (1983) provided an acceptable rationale - and basis for concern - for a re-evaluation of Canadian science education. This became necessary because

> "At issue now is not that students are not learning what science is, or that they are failing to learn enough of it (although these are both of continuing concern to some critics), but rather that students do not come to appreciate the personal, social or national relevance of science." (Orpwood and Souque 1984a p.22)

It is on the basis of the interpretation of these criticisms that the Science Council of Canada sponsored a Study (Background Study 52) in Spring 1980 with three objectives, one of which was to stimulate active deliberation concerning the future for science education in Canada.

And in Japan, it was readily admitted

> "The first (science education) innovative power was fruitful in some part but also made miscarriages by imitating the American projects superficially. Reflecting on and criticizing the innovation during the 1960s, it became clear that more scientific and adaptable researches in science education were demanded. To meet the current demands, the

[5]. *Review of the Secondary Science Curriculum.* Information brief No SC 13 03. Issued as the Schools Council Project Profiles and Index, August 1981.).

> special study project "Science Education"... was started. The project research was continued over nine years under the auspices of a Grant in Aid from the Ministry of Education, Science and Culture. The project involved several sections such as curricula development, teaching material development, a teaching aids programme and educational technology." (Imahori 1980 p.18)

The results were published as books and by 1976 were distributed to Japanese secondary schools. The specific principles of the new project emphasized

> "knowledge should be reduced and the intellectual level of the curricula must be lowered drastically, in order to allow latitude in school life. Observation and laboratory work should be emphasized and the instruction must be carried out on nature or natural phenomena, not on printed knowledge. And individual upbringing and capability development should be highly regarded." (Imahori 1980 p.18)

In the meantime, developing countries, especially those in Asia which had adopted or adapted overseas (American or British) science curricula were, by 1969,

> "experiencing considerable difficulties in their use, as was reported by delegate after delegate at the joint UNICEF-UNESCO regional workshop on planning for science teaching improvement in Asian schools, held in Bangkok, Thailand in 1969. The delegates consistently stated that the imported materials were proving unsuitable for use in their countries, and some countries at least have subsequently moved away from their use. In the Phillipines, for example, following the implementation of the BSCS Biology after it had undergone a thorough adaptation process, it was found in 1967 that students were producing inadequate performances, were finding concepts in the materials difficult to grasp, and were experiencing considerable problems with language comprehension. As a result, the Phillipines has subsequently developed more appropriate materials of its own." (Maddock 1981a p.5)

Finally, in Africa, it became evident to the philosophical architects of the African Primary Science Program (APSP), the rhetoric of the newly adapted (mainly American) science curriculum differs from the reality of their demands or use. Yoloye and Bajah (1980) in a survey raised this issue with various people connected with the development of the APSP, and queried whether Africa was ready for the educational revolution envisaged by the APSP. In various interviews with African science educators,

> "we...posed the problems raised above and it was significant to note that the Africans saw these problems as disturbing at first...The teachers on whose hands APSP materials were placed were ill-prepared to teach science, let alone teach it in this revolutionary way. Although the organizers of APSP held what were described as 'workshops', these were mainly material development and appraisal workshops and not in-service, competency based workshops. The examination system in the education programs of most African countries were still followed and so the problem with the new approach was apparent." (Yoloye and Bajah 1980 p.179-180)

Out of this global malcontent, a new vision for the science education agenda for the 1990s in all countries emerged; and that is a direct concern with making the child the focus of educational enterprise. The humanism of science education has never been more evident. The emergent propositions about science education reform for the 1990s assumed less ideological and political tones than the first generation of science education reform movements. They lost some of the political hysteria that tinted the earlier American and British originated science curricula. They became more pragmatic and more tuned to sociological realities of the context they will operate[6] .

This is because it became rapidly evident that changing the objectives of science curriculum to reflect a modern sociological statement does not yield the desired social transformation expected.

The reviews in this section highlight the various attempts to carry out changes in science education. In the process, the review reveals the strong emphasis placed on science education as an agency of social transformation in both developed and developing countries. The most common set of strategies that emerged are attempts at revolutionizing the science curriculum to achieve this broad objective, but invariably without a corresponding change in the set of assumptions that govern the teaching and learning of science, especially in developing countries. From the various reviews, it emerges that a strong factor in considering the pattern and direction of change in science education is a consideration for satisfying social needs through radical reform in content and rationale of science programmes.

Moreover, the instances cited, even in countries with limited resources, made allusions to provision of science education for all learners. And yet it was not explored whether failure to achieve reasonable measure of outcomes is connected to this mass orientation of science education. In this context, the Science Schools emerge as interesting focus of study.

First, they reverse the egalitarian notion of education. Instead of making science education a province for each child, they deliberately cater for only a selected few. Secondly, they provide a facility for long term production of scientific manpower, using a science curriculum which shares the same broad characteristics as reflected in the science curriculum reform movements (although each evolved independently). The purpose of this research therefore is to determine the outcomes of the Science Schools as social and educational change strategies.

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[6]. The direction of the humanistic theme in science education is further explored by Hernandez (1984) Newton (1986), and as it affects developing countries, Watson (1971).

Chapter 3

Analytical Framework And Instrumentation

3.0 Introduction

This chapter is divided into two sections. Section I discuses some of the various analytical approaches often used in conducting an evaluative study. This provides a basis for the identification of the combination of approaches used in this research. Section II details the development of the various instruments developed for conducting the research.

3.1 Section I: A Study Of Analytical Frameworks

In a previous discussion (see Chapter 2), I have analysed various educational change theories, and four themes that characterize changes in science education were identified. These various reviews provided a prelude to the analytical framework adopted for this research, and provided two overall foci for the research.

The first focus is on the introduction of Science Schools as an educational change strategy, and second, the institutional realities of the Science Schools project which provides an opportunity to examine the nature of the change process in science education. This final focus investigates the assumption that the inefficiency of the educational system is reflected by inability of the prevailing system to meet development goals due to diffusion of resources over large channels of demand in the system.

From these foci, the research investigates two policy rationales implied by the Science Schools project. The first is the expectation that creating specialized educational provisions in science education will yield a significant gain in progress towards outcome of developmental goals. Second is the expectation that provision of enhanced learning facilities will facilitate better interpretation of curriculum objectives.

This research is therefore an evaluative enquiry. Of the many categorizations of evaluations available, two broad classes have been identified: formative and summative evaluation (Scriven, 1967).

Formative evaluation is designed to enable judgements to be made while a programme is still in its initial stages. Summative evaluation is directed towards a more general assessment of the degree to which the larger outcomes have been attained over the entire course, or some substantial part of it. The techniques with which data are collected in both formative and summative evaluations are quite similar and indeed often overlap, especially since the differences between the two evaluative schemes are not too sharp.

What distinguishes them is the way the information collected through each strategy is processed and used. The formative evaluation approach is used to gather information and judge the merit of the focus of enquiry in order to improve its quality. The summative approach enables gathering information to make judgements of the overall merits of the project so that decisions can be made regarding whether to extend or adopt any aspect of it. The audience of the formative evaluator are the designer and developer of a project, while that of the summative evaluator are the consumers, and the policy initiators of the project.

Placing this research within this classification is not entirely without some problems. The project is involved with a far reaching programme of social transformation. And since society is dynamic and evolutionary, the decade that has passed since the project started and this research (1977 to 1987), is an instance on a social scale. In this dimension, the research may be seen as a formative study.

But yet the ten year gap has given an opportunity to look over the project since its beginnings to determine how it evolved and what directions it is taking; more especially as the project has reached a stage where its first products trained at high institutions (mainly Universities) have now graduated and been placed in the labour market. This is a summative perspective. And since the research is mainly concerned with the outcomes and directions of the project, this summative perspective serves to dominate the broad analytical approach adopted in this research.

Various strategic guidelines to data collection are proposed within the formative and summative evaluative schemes. These include objectives approach, countenance evaluation, goal free evaluation and illuminative evaluation. Although most of these approaches were developed for curriculum evaluation, nevertheless each provides a generalized framework against which the outcomes of any educational innovation can be investigated.

Two of these approaches provided me with an analytical framework around which my data was collected. These are the objectives and illuminative approaches. I will describe them first before acknowledging other approaches and justifying my choices.

The objectives approach is most commonly associated with Tyler's (1949) perception of the process of evaluation as determining the extent to which educational objectives are actually being realized by the programmes of the project. But since educational objectives are measured in terms of changes in behaviour, evaluation using this approach is the process of determining the degree to which these changes in behaviour are taking place. Thus this evaluation model is based on determining the discrepancies between intended and observed outcomes in the educational process.

Despite its wide ranging influence on the development of subsequent evaluative approaches, Guba and Lincoln (1981) perceived a number of limitations to the objectives approach of analysing educational changes. First, the approach did not provide explicit judgement of worth or merit, especially in analysis and interpretation of data. Secondly, the model did not provide a criterion by which discrepancies between objectives and performance might be judged. Guba and Lincoln ask how large must such a discrepancy be before a performance is judged to be inadequate? And how can overachievement be judged? Its positivistic overtones might also be considered a hinderence especially in a process of social inquiry requiring interpretative insight.

The second approach is the illuminative approach to evaluation which is derived from Parlett and Hamilton's (1972) proposal of evaluation as an illuminative process.

Illuminative evaluation as an approach to studying educational innovations is rooted in social anthropology and seeks to describe and interpret, rather than measure and predict. It also takes into account the contexts in which educational innovations must operate. The approach is characterized by a process of three phase progressive focusing. In the first, exploratory, phase investigators observe the general process and become familiar with the context of the change. The second phase begins with the selection of a number of occurances, or phenomena associated with the change for a more sustained, focused and intensive inquiry. The third phase consisted in seeking general principles underlying the organization of the change process, by spotting patterns of cause and effect within its operation and placing individual findings within a broader explanatory context (Parlett and Hamilton 1972).

In general terms therefore the aims of the illuminative approach are to study the innovatory project; how it operates, how it is influenced by the various school situations in which it is applied, what those directly concerned regard as its advantages and disadvantages, and how students' intellectual tasks and academic experiences are most affected. It also aims to discover and document what it is like to be participating in the scheme, whether as a teacher or pupil, and in addition, to discern and discuss the innovation's most significant features. Thus the illuminative approach seeks to inform those with an interest in the innovation and assist those who have to make decisions about it.

The basic limitation associated with the illuminative approach is its subjectivity imposed by its interpretative nature. The interpretative paradigm of analysis, according to Burrel and Morgan (1979) is informed by a concern to understand the world as it is, to understand the fundamental nature of the social world at the level of subjective experience. It seeks explanation within the realm of individual consciousness and subjectivity, within the frame of reference of the participant as opposed to the observer of action.

Thus lack of objectivity, or more appropriately, predominance of subjectivity, and assumed potential researcher bias are the main weaknesses of this approach. Some researchers who used this approach, especially in evaluating science education programmes attempted to rationalize the process by introducing what they see as "objective" element in their strategies in order to balance out the subjectivity of the approach. For instance, Boud et al (1985) used this tactic in an evaluation of the Western Australian Physical Science course. In explaining their analytical approach, they stated,

> "Although attracted by this novel and different approach (of illuminative evaluation), we were reluctant to eschew elements of the established, traditional positivist methodologies. We were also acutely conscious of the possible charge of subjectivity, which is frequently levelled at interpretative research and, from the very inception of the project took a number of steps to counteract this possibility. We tended, for example, to validate our impressions and observations by the collection of quantitative data if appropriate. Visits to schools were made on

rotational basis by each of of in turn, major interviews were undertaken by two of us together." (Boud et al 1985 p.88)

Further steps taken include separate preparation of field notes on observations, interviews and perceptions so that they can be cross-checked. A basic flaw of all these precautions is the implicit assumption that objectivity is evidenced by masses of quantitative data. In any event, subjectivity does not imply lack of rationally verifiable evidence. Subjective insights often captures the essence of different people speaking with different views. Moreover, some projects can only be more effectively analysed from a subjective perspective, rather than from a stand which distances the researcher from the mechanism of the process.

Nevertheless, due to its diversity, the illuminative methodology incorporates a wide range of techniques, which effectively utilized becomes a powerful tool in conducting any inquiry with significant emphasis on social dimensions.

These are not the only strategies used in educational evaluation. I have restricted myself to these two because they are not only among the most frequently used evaluative strategies in education, but also because both have contributed to the development of my own overall strategy in this research. Other strategies include the Countenance Model of Stake (1967). This is concerned with the context of operation of the educational change, as well as gathering data to enable judgements to be made by documenting the ways different people see the educational change through observation and gathering opinion. Another approach is Scriven's (1972) Goal-Free evaluation which attempts to free the evaluator to look at processes and procedures (i.e. intrinsic evaluation as well as outcomes), and prevents the evaluator from getting confused between a programme's rhetoric and its success.

Yet still other approaches include Self-Study Evaluation model used to review content and processes of instruction; Daniel Stufflebeam's Content, Input, Process and Product (CIPP) model used to facilitate rational and continuous decision making, and Taba's Social Studies Evaluation model used to seek simple explanations of what works (Jenkins 1976).

The overall strategy adopted for the data collection in this research borrows inspiration from the objectives and illuminative approaches discussed. This is contributed to very large extent by the way the research was initiated. Before going to the field work, I had already collected, rather randomly, a number of documents for the purposes of acquainting myself with the nature of the Science Schools Project. Frequent contacts with the Schools, both on personal and official basis raised questions. This constituted a part of my first phase of progressive focusing on the Science Schools. It started becoming clear to me, from my limited observations of the schools, that there is a need to determine the correlation between the political rhetoric in establishing the schools, and classroom realities of the schools - if only to gain an understanding of the nature of the mechanism of a science education change strategy.

It was from these experiences that the basic framework for a series of research questions was established. Thus by the time I went to field in September 1986 - one year after starting the research - I already had a list of research questions whose answers I wanted to find. All the research questions deal with the extent of the clarity of the objectives of the Science Schools project, and the mechanism for the attainment of such objectives. The formulation of a research strategy with objectives verification as a theme places my approach in a Tylerian objectives mode of evaluation. Indeed as explained by the objective approach, I was interested in determining the degree of correlation between objectives of the Science Schools and their curriculum and overall outcomes of the project.

However, I was also interested in determining the institutional realities of the Science Schools; their day to day routine, the perception of the teachers and students towards their presence in the schools, and the way students were taught. Thus the research has a significant dimension which concentrates on information gathering which places the major thrust of the research as providing a comprehensive understanding of the complex reality surrounding the Science Schools project. This dimension provides me with the second phase of the illuminative focusing. This is more so as the research, like the illuminative approach claims not so much to test as to understand the Science Schools project by examining its background, its organization, its practices, and its problems.

Yet another dimension of concern in the research is the context of the operation of the Science Schools, and any perceived outcomes - both planned and unforeseen. This is to enable more effective judgements to be made concerning the overall merit of the project, and by extension this particular type of change strategy. This reveals a concern with the theoretical as well as developmental implications of the project and completes the third phase of illuminative progressive focusing.

3.2 Section II: Analytical Instrumentation

3.2.1 The Research Questions

This entire research is structured around six research questions. As I explained previously, my interests in the Science Schools project emerged out of my professional contact with the schools. At the same time, the review of the various science education reform movements also provided a focus for my questions, especially as regards to how such reforms affect the development of educational policies in developing countries.

These two concerns - personal contact with the science Science Schools, and interest in the science education reforms - provided a basis for asking a questions or two at a very informal level concerning the uniqueness of science education strategies as agencies of wide scale social transformation. These questions soon graduated to full scale evaluative instruments aimed at attempting to determine the effect of this particular strategy in educational innovation in Kano State. The data collection approach adopted for this research emerged from these research questions. Before looking at the analytical instrumentation and tactics I would like to present the research questions together first.

1. What led to the establishment of the Science Secondary Schools in Kano State?
2. How are the objectives of the Science Schools implemented?
3. What is the emphasis of the science curriculum used in the Science Schools?

4. How are science subjects taught in the Science Schools?
5. What are the attitudes of the students in the Science Schools to science and careers in science?
6. What has been the contribution of the science schools to manpower output of Kano in science and technology since they were first established by the Kano State Government in 1977?

3.2.2 Tactical Considerations

The field work for this research took place between September 1986 to the first week of April 1987. Three overall main techniques were used to collect the data for these research questions. These were interviews, school and classroom observations and documentary analysis. The overall scheme of the research is summarized in Table 3.1

Table 3.1 Research Tactics Grid

Activity	Tactics And Objectives	Population/Source
Documentary Analysis	a. Literature review	
	b. Description of events	Official documents files, memos, reports, minutes
	c. Description of outcomes	of meeting, decrees and laws
	d. Establish how the project originated	
Curriculum Analysis	a. Literature Review of science curricular reform	
	b. Intrinsic analysis of Nigerian materials	Science Syllabus guidelines
	c. Classroom Observation of teaching	8 Biology and7 Physics teachers
	d. Determine quality of syllabus guidelines	
	e. Determine their consistency	
Interviews		
Key Informants	Semistructured	Policy initiators
	Determine how the project originated	(3)
Officials	Structured	Science Board (6)
	Determine how the project is implemented	
Principals	Structured	Science and nonscience schools (7)
	Find how the schools are administered	
Teachers	Structured and Semistructured	Science and nonscience (15)
	Investigate teaching problems/issues	
Questionnaire	55 items including 36 item attitudinal section	300 science and 200 nonscience school students
	Determine students attitudes, and career aspirations and	
	expectations in science	
Classroom Observations	Structured observation in schools	7 Science and 8 nonscience school teachers
	Informal schlool observation of teachers	
	Establish science teaching emphases and strategies	

Interviews were held with various officials and individuals connected with the origin of the Science Schools project. The derivation of the structural framework for the interview schedule for each category of interviewees (key informants, Science Board officials, Principals of Science and nonscience schools and teachers) was facilitated by the literature review of innovations in science education, as well as analysis of documents concerned with the establishment of the Science Schools project collected prior to the field work, including the new Nigerian science curriculum materials. Full details of the derivation of all the interview schedules, the techniques used during the interviews with each category of respondents, the number of people interviewed, and processing of the information yielded by all the interviews are given in Appendix 4.

An analysis of the development plans of the Kano State government especially just before the establishment of the Science Schools provided the guideline to structuring the interviews of the key informants, while analysis of the decrees and laws establishing the Science Schools contributed to the development of the interview schedule for the officials of the Science and Technical Schools Board and the Principals of the schools. The teachers interview was also informed by an analysis of the Nigerian science curriculum materials.

The school observations were of two types; formal and informal. The former was structured and aimed specifically at understanding the nature of the classroom processes. For this, an observation schedule was developed and used to observe teachers in classrooms. The schedule drew inspiration from other science teacher observation schedules, but with a significant input from an analysis of the Nigerian science syllabus guidelines. Full details of the development of the schedule, field work notes on the individual observations, as well as data analysis are given Appendix 2. The informal school observations refer to instances where I simply wandered over the field work site; I had unlimited access to the schools and spent a few hours at each visit looking at laboratory inventories and noting how the equipment was used by the teachers and students.

3.2.2.1 Research Question 1

> ***What led to the establishment of the Science Secondary Schools in Kano State?***

The focus of this research question is on the policy antecedents of the Project. It specifically wishes to find out:

a) The processes through which the need for the Science Schools was identified, as well as the educational, social and economic context existing in Kano at the time.
b) The purposes the schools were meant serve, and the nature of their most fundamental characteristics.

The main source of information on this research question is the policy makers. But the question also lays a significant emphasis on the social and economic context existing in Kano at the time the Schools were initiated. This is more since the Schools were a response to what the Kano State government perceived as a social need, and the apparent inadequacies of the existing educational system to provide appropriate science education to secondary school students in the State.

The first data gathering instrument developed was a set of Interview Schedules aimed at determining the factors that led to the initiation of the project. Some officials involved with the project at its early stages were interviewed. These were specifically those members of the Kano State Civil Service who were part of the Kano State Executive Council which finally gave the approval for the implementation of the project were contacted. The sampling focused on key members of the 1975 Manpower Planning Committee of the Kano State Government. The reason for this was because this was the organization, based in the Ministry of Economic Planning that proposed the Science Schools. Appendix 4 provides full discussion on the sampling procedure.

The second source of data on this question is documentary evidence. Two categories of documents are clearly identified. There are those that are public and are accessible (even though difficult to purchase from the office of the government printer or locate in libraries). These provided significant information about the social and economic antecedents to the establishment of the Science Schools.

The other category encompasses those documents considered classified, and are not normally available. However, I was able to obtain quite a few and these yielded significant insights about the objectives set out for the Science Schools. These included the complete set of 1985 Minutes of the Science Board. All the documents obtained and used in this research are fully listed in Appendix 5. Eventually the Law establishing the Science Schools was released by the Kano State government in 1982. The entire Law which characterizes the Science Schools is reproduced in Appendix 5.

A limitation is the small size of the interview sample, which was in the final analysis made up of four respondents for this research question. However, the small sampling size is almost balanced out by the nature of the respondents who were key informants in respect to the origin of the project, and provided what would appear to be comprehensive information about the project.

3.2.2.2 Research Question 2

How is the Science Schools project implemented?

Sub-questions are:

a) to what extent do the Science Schools achieve the objectives set for them?
b) what makes them achieve their objectives?

The focus of the data gathering in this dimension is the Science and Technical Schools Board, as well as the Principals of the four Science Schools. The Science and Technical Schools Board is the agency responsible for implementing the project. Key officials of the Board were interviewed. Access here was easier to negotiate than in the case of the key informants previously discussed because of the small nature of the Science Board. The entire buildings of the Board occupied a small block, with the most senior officials with a concern for this research not exceeding five in number.

Although there were four Science Schools, I interviewed only three Principals, rather than four. This is because my focus was the schools rather than the Principals, and each of the three schools I did Principal interviews with had some factor that made its selection appropriate. The first two were the oldest (D/Kudu and D/Tofa). And due to time constraints, I was forced to make a choice of one between two of the newer Science Schools (Taura and K/Hausa). Taura being nearer to Kano (93 km) than K/Hausa (175 km), and with the added novelty of being the first female institution of its kind, dominated my attention and became my third Science School. Moreover, all the three have graduated students at the WAEC examination. Kafin Hausa Science School, at the time of the research was yet to present students for the WAEC examinations.

3.2.2.3 Research Question 3

> ***What is the emphasis of the science curriculum used in the Science Schools?***

This seeks to determine the intrinsic nature of the science curriculum used in the schools. The curriculum is not unique to the Science Schools; it is a federal curriculum newly introduced into all Senior Secondary Schools (into which the Science Schools are classified) in September 1985. Prior to this, the schools, like most of the other schools in Nigeria, were using what the developers of the new science curriculum considered a “traditional” science curriculum.

The purpose of the analysis was to determine the intentions of the producers of the Nigerian science curriculum and the quality of the materials produced. Four criteria were used to assess the quality. These are the internal consistency of the curriculum in terms of the clarity of its expression, the relationship between its stated aims and detailed performance objectives, the degree of progression from year to year in terms of its emphasis on the stated performance objectives, and its general emphasis on skills and processes in science. The choice of these criteria is purely subjective to this research and are adjudicated to be the four main (but not only) points a classroom teacher will wish to clarify as a basis for using the science curriculum effectively as intended. Thus these criteria are some of the key issues the analysis used to explore about the new Nigerian science curriculum.

Because in Nigeria the term “curriculum” was used to refer to the syllabuses in Biology, Chemistry, and Physics only, the analysis was necessarily restricted to these “curriculum materials.” There were no accompanying text materials produced which would have increased the depth and scope of the analysis and provide greater understanding of the intentions of the curriculum developers. The analysis is therefore limited only to the structure of the syllabus guidelines.

The analysis was carried out using an adaptation of an analytical scheme developed by West (1974) at the University of Sussex. Before this was adapted, a number of other schemes were considered. These included the Sussex Scheme (Eraut et al 1975) which deals with fundamental problems and issues as well as procedures and techniques involved in curriculum analysis and evaluation. The scheme was developed as a general scheme available for analysing any subject at any age group. Its comprehensive nature makes it too unsuitable for the analysis of a list of curriculum intentions as in the case of the Nigerian science curriculum.

Another analytical scheme considered was the one developed by Orpwood and Souque (1984a) and their colleagues at the Science Council of Canada in the analysis of policy guidelines and science textbooks used in Canadian high schools. This was also not eventually used because of its regional specifications. It drew too much on Canadian policy context to make it a universal framework of analysis (see also Orpwood and Alam, 1984).

Finally, the West (1975) scheme (adapted from West 1974) was considered and used, especially as it was tried by two other researchers in the same field; Tan (1979) who used a combination of schemes developed by Eraut et al (1975) and the West scheme to evaluate the Malaysian Biology curriculum, and Lewin (1981) who used an adapted version of the scheme to analyse Malaysian Integrated Science curriculum materials.

The West Scheme was adapted for this research because the original scheme was developed to carry out a summative evaluation of a curriculum (the Nuffield Chemistry Project) whose stated aims and suggested teaching strategies were quite similar to those stated in the Nigerian science curriculum. A limitation of using scheme was lack of full curriculum materials for the Nigerian science curriculum, i.e. text and pupil materials. This is more so since the original West Scheme was developed to analyse a curriculum with pupil and teacher materials and other guidelines. Consequently, the use of the scheme in this research is limited to analysing only the syllabus guidelines. Despite their limitations, the new Nigerian syllabus guidelines, however, were interesting in their attempts to provide a comprehensive guideline for the teacher regarding what the developers of the curriculum believe science teaching should emphasize for Nigerian children.

The full scheme used is reproduced in Appendix 1. The analysis of the curriculum materials, however, is only a facet of an intrinsic evaluation of the science curriculum as used in the Science Schools. The materials cannot be seen in isolation. This research question is also concerned with the way such curriculum is interpreted in the Schools. This latter aspect is fully explored through Research Question 4. Data from interviews with officials, teachers, and classroom observations was incorporated into the analysis of the science curriculum materials where appropriate.

3.2.2.4 Research Question 4

How are science subjects taught in the Science Schools?

This research question seeks to determine the pedagogical basis of the Science Schools. It is the first move towards a deeper analysis of the innovation. Subquestion are:

a) How do the science teachers interpret the aims and objectives of the science curriculum in the classrooms? What affects their interpretations?
b) In what ways does the teaching of science subjects in the Schools reflect the curriculum emphasis of the science curriculum?

c) What do the students consider difficult in learning science in the Science Schools?
d) What aspects of learning science do the students prefer their teachers to emphasize?

The instruments for this research question are observation schedule, interview schedules, student questionnaires and documentary analysis.

The observation schedule seeks to complement general observation of teaching strategies. Its categories were aimed at measuring the most predominant teacher behaviour in the classroom. But the observations would be incomplete if attempted on their own. The objective is not just to record classroom behaviours, but note these behaviours in relation to a specific instructional context.

While the Observation Schedule developed for this research was not based on any specific previously developed schedule, it nevertheless drew upon the previous works of other evaluators who developed schedules to evaluate the teaching of science curricula with similar orientations to the Nigerian science curriculum. In particular, the schedules of Alexander et al (1974) and Eggleston et al (1976), both developed for the Nuffield science teaching projects, proved helpful in further clarifying the dimensions of classroom behavior to look for during the observations of science lessons sharing the common themes of the science curriculum reform movement (see Chapter 2).

However, the final observation schedule used was developed after the analysis of the Nigerian new science curriculum. Thus the advantage of this observation schedule is that it enables the observer to compare observed behaviour with the stated expectations of the curriculum. Developing an observation schedule independent of the curriculum has the risk of imposing structure on the curriculum which may not be intended by its developers.

Nonscience schools were included in the observation programme. This was not with the purpose of making absolute comparative judgements on the two categories of schools, (moreover, the emphasis of the research was not to compare them) but to gain an insight into the science teaching and learning processes in the conventional schools in Kano.

Two science subjects were selected for the classroom observations. These were Biology and Physics. The main reason for choosing these two subjects was based on the strategic needs to choose more than one science subject, but less than three, for the purposes of the observation.

A total of 17 individual lessons were recorded in the Science Schools covering 1320 minutes of classroom time, while 11 lessons were recorded in the nonscience schools in 740 minutes. Although the observation had the purpose of determining the teaching emphases and strategies adopted by the teachers, such strategies cannot be fully reflected in the observation schedule, or by the process of ticking off behaviours as they occurred in the classroom. It is for this reason the observations were followed by individual interviews with the teachers, as well as the school authorities. The dialogues in the classroom between the teachers and the students also yielded significant insights into the process which cannot be wholly reflected in the observation schedule.

A total of 15 Biology and Physics teachers were observed and interviewed, although only five were willing to allow their views to be recorded. Seven teachers observed were from the two Science Schools, and eight from the two nonscience schools. The full description of the techniques used during the observations and the timings for the observations are discussed in Appendix 2.

Finally, selected responses to the questionnaire items administered to the students serve to provide further insights into what the students themselves think of some aspects of the teaching process. The items selected specially reflect their own perception of certain aspects of learning. These include pupil learning strategies, perception of difficulty during science lessons, and views concerning the emphasis of their teachers during science teaching.

3.2.2.5 Research Question 5

What are the attitudes of the students in the Science Schools to science and careers in science?

This seeks to determine the level of interest the students in the Science Schools have to further science studies. Sub-questions in this category include:

a) what are the personal characteristics of the students of the Science Schools?
b) What is their general attitude towards science and careers in science?

The attitudes of the students were measured through an attitude questionnaire. The questionnaire is divided into two sections. Section I seeks to collect personal data on the respondents as well as career choices and learning perceptions. Section II is the main attitudinal section and has 36 items divided into three scales. These are: personal response to science, science in society, and school subjects and experiments. The full questionnaire, its development as well as its statistical treatment are discussed in Appendix 3. The appendix also carries out a full discussion of the sampling procedure and the analysis of the questionnaires.

In the analysis of the data from the questionnaires intra group comparisons (between the girls and boys who responded in the Science Schools) were not made because the number of questionnaires returned from the girls' school was too small (47) to yield meaningful pattern of either similarities or differences when compared with the 253 questionnaires returned from three boys' schools.

Similarly, the nature of the differences between the Science and nonscience school students, particularly the selection of the best students for the Science Schools, makes it unwise to consider inter group comparisons on attitude formation in science, or towards careers in science.

3.2.2.6 Research Question 6

What has been the contribution of the science schools to manpower output of Kano in science and technology since they were first established by the Kano State Government in 1977?

This seeks to determine the outcome of the Kano State Government investment in the Science Schools, especially in the area of specialized manpower output.

The research question orients itself to the third phase of the illuminative approach by focusing on the outsiders. It seeks to inform about the actual manifested potential of the Science Schools project, and the extent to which a measure of its objectives have been met.

This dimension also seeks to determine any unintended outcomes of the project, either at the present or which may occur in the future.

The main source for this research question is documentary evidence. The documents available enable judgements and decisions to be made regarding the outcomes of the Science Schools project, both from an analytical and policy perspective. Interviews with officials have also provided further insight into the policy perceptions of the outcome of the project in Kano State, and its future.

3.2.3 Overall Limitations

No attempts are made to determine the actual impact of the Science Schools project on the labour market. This is to say it was not part of my design for the research to find out the employment prospects of the graduates of the schools, what the employers think of them, and how competently they perform their tasks in relation to other workers in any organization.

This limitation is acknowledged because while the Science Schools can take a measure of credit or blame for the quality of their products immediately after leaving the Schools, other institutions the students proceeded to must also accept a responsibility. In effect, an evaluation of the products of the Science Schools, especially those who entered the labour market after graduating from universities or other high institutions, becomes more or less an evaluation of these institutions, rather than the Science Schools. Moreover, such follow up study is beyond the scope of this research.

But from the documentary evidence obtained, particularly that pertaining to academic achievements of the students, as well as their placement in higher institutions, judgements can still be made about the Science Schools as specialized manpower development strategies.

Chapter 4

Education, Schooling and the Social Response in Kano, 1910-1985

4.0 Introduction

This chapter begins an analysis of the factors that led to the establishment of the Science Secondary Schools project in Kano. Such analysis inevitably has to contain at least two major elements. A sociological survey which investigates the social response to general schooling in Kano, and an economic backdrop which provides a rationale for the perception of the Science Schools as long term mechanisms of social and economic advancement. The economic background leading to the Science Schools project is explored as a prelude to the genesis of the project in Chapter 5.

This chapter begins the first part of the analysis by briefly analysing the social context of schooling in Kano State from 1910 to 1985. The survey provides a framework for understanding the rationale of the Science Schools project as part of an educational change strategy aimed at maximizing the output of pupils with scientific qualifications.

To guide the analysis, the chapter sets out to answer the following research question:

What led to the establishment of the Science Schools in Kano?

The analysis is divided into two sections. Section I is a survey of the historical and social context of education in Kano, while Section II is an analysis of governmental efforts at providing a more effective educational service in Kano.

4.1 Section I: Social Response To Education in Kano Before Independence

4.1.1 Historical Antecedents

Kano State, one of the nineteen states of the Nigerian federation, is located in far Northern Nigeria (see frontispiece map). It was carved out of the former Northern Region in 1968. The people are predominantly rural with “up to 80 per cent of the state’s population actively involved in agricultural production” (Kano State 1981a p.82). The state is also the most populous in Nigeria, because although the official census taken in 1963 puts the population of Kano province at 5.77 million,

> “federal projections made predicted an estimated 8.91 million inhabitants by 1980. However, the commonly accepted population figure for today is 10 million people.” (Kano State 1981a p.19)

Like in the rest of Nigeria, accurate and exact population figures are not available and what is given is based on projections and estimates. And despite its agrarian status, “Kano enjoys one of the highest industrial growth rates in Nigeria, ranking second after lagos (the capital)” (Kano State 1981a p.95)

The single most powerful striking social feature of Kano State is its Islamic nature. The 1963 census records Kano as having a Muslim population of 97.4% (Kano State 1974). With this background, no meaningful study of any aspect of development in the state can take place without considering that Islamic religion plays the dominant role in the way people perceive life in Kano.

Islamic became firmly established in Kano in about 1360 (Hogben and Kirk-Greene 1966), and with it, a system of education based entirely on Quranic teaching was also established in a significant part of Northern Nigeria. And this became the main mechanism of training and character formation for young people before and after the colonial arrival of the British in the Northern Region in 1903.

In order to defuse the possibility of an uprising as occurred in other parts of the colonial empire with strong Islamic culture (Sudan and Egypt, for instance), the British adopted a tactical policy of pledging non-intervention in religious affairs of the Northern peoples, especially the Muslims, upon their arrival and subsequent subjugation of Northern emirates in 1903 (Graham 1966).

This pledge involved preventing Christian missionaries from establishing schools in Islamic areas of the North, although they were given free access to "pagan" areas of the North and Southern Nigeria by the colonial administration. The consequence of this was the spread of Christianity and modern education to all areas in Nigeria except the Muslim areas because up till then, the formal system of education necessary for modern development was provided by Christian missionaries who used the education as the main strategy for getting converts.

This identification of modern education with Christian doctrine remains the major historical reason for the non-acceptance of modern education among Muslim Northern Nigeria - and which has political consequences for the entire country after Nigerian independence from the British in 1960.

Moreover, in a area where Islam has been established as a way of life for centuries, the modern system of education was not considered relevant to this way of life. For instance, in 1900 when the Protectorate of Northern Nigeria was established by the British Colonial government,

> "Lord Lugard estimated that there were 20,000 Koranic schools, in which no less than 250,000 pupils were being taught. That the way of life lacked many of the essentials necessary to a country to take its place among the countries of the world, there is no doubt, that a high order of civilized life existed before the days of the occupation is equally evident." (Williams 1960 p.6)

But to interact more meaningfully with the people they rule, the British needed to establish a system of education and training which will provide some basic mechanism of furthering their administrative objectives (Allen 1969). It was clear such system of education must not identify with the Christian doctrine, and if it cannot be made in a way the potential students will identify with it, then it should not alienate them either.

The quite revolutionary - for a colonial government - plans of establishing a schooling system along these lines were initiated in 1909, and in 1910 the colonial administration appointed Hanns Vischer the first Director of Education for the Northern Region to start two schools in Kano

> "first at Nassarawa on land given by the Emir and later in Kano City...and flourished and fulfilled their purpose in a marked degree, even though they had at first to deal with pupils aged 6 to 40. For these schools came at first a dribble, which developed into a steady flow of trained teachers, literates of the ruling class and skilled artisans. That the flow never became a flood is due to the first world war. Wars and economic recession have dogged the development of education in Northern Nigeria and no less than three serious crises have occurred." (Williams 1960 p.10)

The establishment of these schools summarizes the intensity of the struggles that went into attempts to encourages the local populace to send their children to school generally in the Northern Region among the Muslim communities.

4.1.2 The Social Response

Almost seventy years after those pioneer schools were established in Kano in 1910, the dribble remained almost the same. For instance, in 1985, the total school population of the students in post primary institutions was 114,487 spread over 206 secondary schools, teacher training colleges, commercial schools, technical schools and vocational centres. Of the 169 secondary schools, 45 were "grammar" or Senior Secondary Schools (Grade 10-12) while the rest of the 124 were Junior Secondary Schools. The number of students in the Senior Secondary Schools was 47,007. This represented some 41% of the entire post primary population, while 34,529 or 30% of the students were in the newly established (in 1982) Junior Secondary Schools (Kano State 1985b).

These figures can only be appreciated better if the entire population of the children of the secondary school age in Kano is considered. The 1963 census places the 10-19 year old population of Kano at 1,350,235 out of a total population of 5.77 million[7].

This was 23% of the population (Kano State 1974). Assuming these figures remained static, and represent a constant number of children of that age in Kano every year, with a total number of children in post primary institutions at 114,487, only 8% were attending these schools.

But this actually represents an increase over the 1963 school population figures. In 1963, there were a total of 2465 students spread into six secondary grammar schools (1233), five technical and vocational schools (260) and two technical training colleges (972). This represents 1.8% of the 1,350,235 children in Kano of school age (Kano State, 1970). The general trend of enrollment over the years since 1976 when the moves to establish the Science Schools as potential solutions to the problem of education as a social service in Kano State were made to 1984 is shown in Table 4.1

[7]. This age group is selected for analysis here because it is from this cohort the school population most commonly identified as being the basis for further training and manpower production is taken.

Table 4.1: Post-Primary School Enrollment In Kano State, 1976-1984

Year	Students	% Attendance
1976	23967	1.7
1977	31786	2.3
1978	35315	2.6
1979	38293	2.8
1980	57509	4.2
1981	60629	4.4
1982	93133	6.8
1983	103680	7.6
1984	109635	8.1

(Source: Kano State 1981b, 1985b, 1986b. Percentage attendance computed from given 10-19 year population (1,350,235) in Kano State in 1963).

The most significant feature of Table 4.1 is the persistently low percentage of enrollment of students in various post primary institutions in Kano State over the years in relation to the post primary school age population. This becomes a compelling political and social problem in that the basis for satisfying manpower requirements for modernization is simply not available.

An indication of the persistence of this problem for many decades in Kano after the Nigerian independence is shown in a report where the Governor of Kano State

> "blamed the shortage of indigenous manpower in the state on parents who refused to allow their children to go to school." (*Sunday Triumph* 23 September 1984)

And because government is committed to programmes of social transformation requiring educated manpower, the State government often had to resort to drastic measures to enforce parents to send their children to schools. In one instance, it was reported,

> "twenty six parents have been taken to courts in Kano State because they refused to send their children to school. The state government had only recently warned parents to either send their children to school or face 'unpleasant consequences'. The trail judge warned and discharged them on the understanding that they would send their children to school immediately. The parents were warned that if they continue to refuse to send their children to school, they would be sent to jail. Some traditional rulers have also been involved in the campaign to persuade unwilling parents to send their children to school." (*New Nigerian* Wednesday 4th July 1984 p.16)

It is interesting to note the persistence of this problem of getting parents to send their children to schools, long after it has become obviously clear there was no longer any formal association between modern education and Christianity; and despite concessions such as the early introduction of Islamic Religious Knowledge in the school curriculum.

But since modern education has been identified as necessary for modern nation-building, it became imperative for the Kano State government to find ways of making it more acceptable. The fundamental strategy adopted by the Kano State government to achieve this was to make education as free as possible for Kano State indigenes. This case was presented by the Governor of Kano who in interview in 1984 argued against fees or levies in education in Kano:

> "if we say we are going to impose a levy on education or school fees we must remember that in some areas we still have to chase people to go to school and even if they go you have no guarantee they will stay because once the rain season comes their parents will just withdraw them automatically. We are now battling to make them understand how important it is for them to acquire education. If you impose a levy you are jeopardizing your chances of getting children to go to school*." (New Nigerian* Wednesday 25th April 1984 p.3)

This strategy, far more attractive than threats of incarcerating errant parents, became the basis for wider provisions in general education through a system of generous scholarship provisions for Kano State students, especially those wishing to study science and technological disciplines in institutes of higher learning.

4.2 Section II: The Education Review Committees

Other strategies of identifying, and more importantly, coming up with a lasting solution to the use of education to solve the developmental problems in Kano adopted by the government were in the establishment of various education committees since the creation of Kano in 1968 from the former Northern Region. The first major education committee was established in 1975 after a military change in government. In his first broadcast to Kano State on 5th August 1975, the new Military Governor announced,

> "education will be placed on the top priority of my government's development projects as it is my firm belief that the development of human resources should form the corner stone of all our development. I will ensure that education spreads at all levels throughout the state. To this effect, I shall set up a body to examine and report to me on all aspects of educational development in the State with special emphasis on our areas of weaknesses." (Kano State 1978 p.9)

As a first step, the Kano State Education Review Committee, the Galadanchi Committee, was set up by the Kano State government "to review all aspects of education in Kano State to so that improvements could be affected." (Kano State 1976a p.1). The Committee was given eleven terms of references, the first two of which formed the backbone of the Committee's objectives where the Committee was asked to

1. Examine the causes for relatively slow educational progress in the state and make recommendations for speedy improvement. In this respect, you should identify the most backward parts o the State and suggest remedial measures.

2. Examine the content, method of teaching and relevance of our school curricula and see how these affect the falling standards in our schools and make recommendations for improvement." (Kano State 1976a p.1)

The Committee submitted its Report in January 1976. The Report dwelt on historical factors and identified a general resistance to western education in kano due to historical links between modern education and the early Christian Missionaries in Nigeria. Its recommendations for the first term of reference included suggesting

1. Efforts should be made to make the general public aware of the fact that education can and should be pursued for its own sake. It should not be seen as means of getting a job through which to earn a livelihood.
2. Attempts should also be made to separate western education from religious education and to show the general public that this type of education is not in anyway leading them towards or converting them to Christianity." (Kano State 1976a p.7)

The government issued a White Paper on the report of the Education Review Committee in June 1976. The government accepted the recommendations of the committee in its first term of reference. In responding to the committee's recommendations on the second term of reference, the government came to following decisions:

1. The government will set up a committee of experts within the Ministry of Education to make recommendations on the detailed contents of the course of instruction at the Primary and post primary levels, on methods of instruction an on review of textbooks for all course. The Committee will examine these matters with reference to practices prevailing in other States so as to suggest modifications and innovations which would be in the best interest of the State.
2. A fact which did not attract adequate attention of the Committee but which has been a matter of extreme concern for the government is th the poor quality of science education in the state. This had led to lack of diversification of course in the state's secondary education, discouraged entry of students of Kano State origin in science courses at degree levels in the universities, and inhibited the growth of skilled manpower. Government is therefore taking steps to improve science education in all secondary schools in line with the new 3:3 system of secondary education to be introduced form September 1977." (Kano State 1976b p.5)

It is interesting the Kano State government White Paper was more concerned about the role of science education as an agency of social advancement than the Committee report. It is also significant the government expressed a lack of confidence in the education it provides by describing the science education in Kano then as of "poor quality." Indeed as the government observed later,

> "The present acute shortage of manpower in Kano Sate results largely from the lack of the right kind of educational facilities. In more of our secondary schools, the available science teaching facilities, laboratories, equipment, materials compared against actual school requirements are far too inadequate. In almost all secondary school there is a general

shortage of qualified science teachers. The students going into secondary schools do not appear to appreciate the career prospects of personnel with the needed science qualifications. " (Kano State 1979b p.138)

It is interesting the government made these observations by itself - actually expressing a crisis of confidence in its own provisions for attainment of the educational outcomes it would have preferred.

And although the idea of Science Schools possible solutions to the problems identified by the government White Paper should have emerged from the Galadanchi Committee (its main task is to identify solutions), it is even more significant it did not, even though the Committee was made aware of the nature of the problem when it was gathering its data. As the Secretary of the Committee, Alhaji Ado Gwaram recalled,

> "The idea of Science Schools did not come from the findings of the Galadanchi Committee. Some Kano scientists such as Professor Ibrahim Umar (former Vice-Chancellor of Bayero University) did appear at the Committee. In particular Ibrahim Umar made several pleas and appeals for doing something about secondary science. He didn't say 'do the Science Board.' But he said you cannot continue a base that has no science attached to it. So our attention had been drawn to the uselessness of doing things the way we were doing them, by eminent people saying look you cannot develop without science. That awareness had been made clear to us by very many people. But directly that we should set up a Science Secondary School was not recommendation of the Galadanchi Committee." (Interview 22/2/1978)

Thus considering the amount of evidence given by practitioners concerning the role of science in development during the most fundamental educational review committee in Kano, it is curious recommendations which bear elements of the Science Schools philosophy were made by the government directly.

There is no doubt with such low enrollment in schools (as indicated by Table 4.1), the Kano State government needs to determine ways of increasing the number of children attending schools to provide a basis for sufficient manpower from Kano State in science and technological disciplines. This became more so with the weakening of the Nigerian economy from the late 1970s which reduces the ability of all the State governments to recruit expatriate manpower from overseas. However, what is equally important is a long term solution which will turn out to be cost-effective in the final analysis and serves the intellectual needs of the learners.

The next Committee established to look into educational problems with the hope of maximizing educational output was a Study Committee established by the Kano State Ministry of Education in 1979 to

> "Identify the numerous problems obstructing rapid educational development and to re-vitalize all existing educational resources in order to achieve better results. " (Kano State 1979a p.1)

One of the terms of reference given to the Study Committee was to "examine the methods through which the State can increase the number of qualified candidates for admission into our universities bearing in mind the financial constraints the country is at the present" (Kano State 1979a p.34).

After its deliberations, the Study Committee made the following observations in a report submitted to the Kano State Commissioner for Education in 1979:

> "Kano State is facing an acute shortage of qualified candidates for admission into tertiary institutions. If the State is to adequately prepare itself for economic and social development, deliberate educational programmes must be undertaken whereby the number of qualified graduating students from the State's post primary institutions can be improved s soon as possible." The Study Committee's recommendation about this situation is "efforts must therefore be directed towards maximizing available facilities, teaching staff and students." (Kano State 1979a p.35)

It is interesting this Study Committee is more geared towards increasing output. And yet, like th education Review Committee, did not provide any tangible basis for strategies to achieve this objective in its recommendations. No one is clear on how "efforts can be directed towards maximizing available facilities" especially since the Study Committee was reminded to consider the economic implications of any recommendations.

The third Committee was a Problems and Prospects of Education Committee set up by a civilian administration in its halcyon days but just before a major upheaval in 1983 which ushered in a new military regime. The observations of this Committee, no less tan others before it, served to indicate the general problems of schooling in Kano State in 1980s. For instance, the Committee observed,

> "The people who go through education are largely seen as people who have during the course of their education acquired new values. They abandon their culture for something alien to the majority of the people. They lack a sense of identity, have no feeling of commitment to their people or society, and are not ready to make sacrifices for the society. At present, there is a passive decline in the quality of educated elements. This brings about a downward trend in the quality of ideals, social cohesion, moral consciousness and desire for justice. And the children knowing the feelings of their parents lack enthusiasm for education even when they are forced to go to school." (Kano State 1983 p.21)

This lack of enthusiasm underscores the general transformation modern education underwent general in Northern Nigeria, but particularly in Kano since its introduction in 1910. Three distinct stages of this transformation can be traced.

In the first stage from 1910 up till the end of the Second World War and before the start of nationalist agitations for independence, education was perceived as an agency for Christian conversion, and on this basis, was not accepted. This, of course, was caused by the historical antecedent which linked schools with Christian missions.

However, with the coming of nationalism and the prospects of obtaining political power, education entered a second stage of transformation when it was partly accepted because it became a mechanism for gaining political control. But gradually it became evident after a series of changes in government that acquisition of education does not lead to political control. Thus the early tactics of Northern political leaders in using education as basis for gaining more effective control on their affairs was not wholly successful, especially when people became aware other, more powerful forces were pre-requisite qualifications for political advancement in Nigeria, rather than extensive level of schooling.

Thirdly, education became equated with the labour market in the 1970s at the height of Nigerian economic prosperity when educated manpower was needed all over the country. It became a guarantor which will secure a safe acceptable job in any productive sector of the economy. But the depreciation of the Nigerian economy in the early 1980s soon made it un-viable as a mechanism of personal advancement in the society. In the first instance, jobs became scarce as the labour market became saturated in some fields (in Kano such as social sciences and administration).

Moreover, due to unpredictability of the market forces, it became apparent education was not adequately preparing learners for the labour market. This became a convincing reason (and a basis for the New National Policy on Education), especially for those who believe they could make a living as commercial entrepreneurs for instance, to resist the educational process and perceive it as irrelevant to their needs.

The ultimate result of this synthesis in Kano was a disenchanted populace that does not see modern education as a relevant force in its affairs. And as such, refuses to co-operate with the government in appreciating its significance as a social service. As acknowledged by the then Director of Education in Kano State,

> "It is important to note that most of the so-called experts on education tend to overlook the peculiarity of this State in their efforts to produce a meaningful guidance on all aspects of education, in particular the curricula. The present rigid compartmentalization of education and the neglect of cultural and religious background of the people have thus contributed a lot in making the curriculum in this State mainly irrelevant. Even among the enlightened members of the society, the concept of education is often limited to its narrowest and alien sense, ignoring the culture, religion and the peculiar outlook of this society." (Imam Wali, Kano State 1979b. p.1)

However, the Problems and Prospects of Education Committee, like the others before it, did not provide any specific strategies to solve the problem. For instance, the Committee could only recommend the following as a basic strategy:

> "Community representation in education committees, boards, commissions and other educational bodies must be created. Where they are already in existence, efforts should be made to see that only honest,

dedicated and committed people are often chosen. The existing school advisory committees should be made operative." (Kano State 1983 p.21)

But before the civilian government could study the findings of the Committee (submitted in May 1983), a military coup occurred on 31 December 1983 that puts the entire civil service into a new perspective.

Thus even up to 1983, it was clear problems exist with regards to perception of education in Kano as vital social service. But the precise solutions which will make education widely accepted as a functional service aimed at rapid social transformation were not clear, despite the numerous education review committees established by the Kano State government. This is surprising since the problems of educational development, and the strategies of maximizing output should have been the direct outcome of these committees. It is clear therefore other events in Kano State have to be analysed as the direct antecedents to the Science Secondary Schools project in Kano, and it is is to this that I now turn.

Chapter 5

The Emergence of the Science Secondary Schools, 1977-1987

5.0 Introduction

This chapter analyses the creation of the Kano State Science Secondary Schools as an educational change strategy aimed at the more effective production of scientific and technical manpower. The analysis is guided by the research question whose focus is: What are the factors that led to the establishment of the Science Schools? What objectives were they meant to serve? What are their most fundamental characteristics?

The analysis is divided into four sections. Section I analyses the social and economic background of Kano State as prelude to the origin of the Science Secondary Schools Project. Section II analyses the structure and constitution of the Science and Technical Schools Board, which is the agency responsible for the development and implementation of the Project. Section III analyses the Science Schools in terms of their most fundamental characteristics, paying particular attention to the students, the teachers and the instructional facilities. Section IV concludes and outlines the major findings of the analysis.

5.1 Section I: The Genesis of the Science Schools Project

Kano State was created out of the then Northern Region of Nigeria in 1968. The emergence of the new state was not without some problems for the State administration because Kano State lacked indigenous (i.e. of Kano State origin) expert scientific and technical manpower considered essential for social development.

This situation arose because schooling, as the main agency of manpower training in Kano, was still to gain wide acceptance among the populace. It was still viewed with suspicion as a forum for conversion to Christianity. And through the decade from 1968 to 1978, two successive Kano State governments had tried all sorts of strategies to ameliorate the situation (see Chapter 4).

This was the situation in Kano when the oil boom era exploded in Nigeria in the early 1970s, and which saw the initiation of many developmental projects all over Nigeria aimed at bringing about rapid social transformation. As a result, the Kano State government launched a very ambitious developmental programme in 1971.

The strongest feature of this plan was its attention to agriculture and industrial development. As the introduction to the Plan stated,

> "It is a farmers plan; and this is as it should be considering the fact that agriculture is the backbone of Kano State economy in spite of its being bogged down by land and water scarcity and adverse climate. But, while agriculture is given due priority, it is realized that Industry is the hope for the future considering the density of population and the natural limitation of horizontal expansion in agriculture. This is more when account is taken of Kano's high industrial potentialities and Commercial importance. Industry is therefore given equal priority with agriculture in

> the belief that only balanced growth could serve our desired economic and social objectives. Basic and social infrastructure are also adequately catered for because they are pre-requisites for the development of other sectors." (Kano State 1971 p.4)

But agriculture and industry were not only areas of social development which received attention. Other basic social infrastructures such as transport, telecommunication, electricity generation and distribution and health development, which all require heavy investment, received the appropriate commitment from the Kano State government in the Plan.

These commitments manifested themselves in the establishment of many government parastatal agencies charged with implementing the Development Plan, as well as with continuously carrying out activities that will bring about rapid social progress in Kano State. These included the creation of Health Services Management Board, Urban Development Board, Rural Electrification Board, Water Resources Engineering and Construction Agency, and the Hadejia-Jama'are River Basin Development Authority, which, between them covered the vital social concerns of food, health, environment and general social welfare. These agencies were all in addition to existing various Ministries (such as Health, Agriculture and Natural Resources, Works and Housing).

The tasks of co-ordinating and seeing to the implementation of the various developmental projects in Kano were given to the Ministry of Economic Planning. As stated in the Plan,

> "The role of the Ministry of Economic Planning becomes more crucial at the implementation stage. Its role will be that of co-ordinating and follow up. A close Follow-Up of the Plan Implementation will not only ensure that the priorities are not distorted by one reason or another, but will also allow us to discover bottlenecks of any type in due time, and to introduce the necessary corrections when required. ***It is therefore most essential that the ministry of economic planning be closely associated with the implementation of each project***." (Kano State 1971 p 101, including emphasis)

The only major obstacle to these ambitious plans - or, as the Plan identifies, "bottlenecks" - was the expert manpower in science and technological fields. While with a vibrant Nigerian economy the Kano State civil service could afford facilities where the required manpower was recruited from overseas, the government gradually realized such manpower could not be relied on to remain for a long period.

To confound the situation, local substitutes (i.e. those from Kano State) that can be relied to stay on a permanent basis were not available in the quantity or in the disciplines required. This is reflected in the overall manpower situation in Kano in the period in Table 5.1, which reveals a shortage of indigenous manpower in all fields of social and economic development at the creation of Kano State.

Table 5.1: Kano State Manpower Strength In Science And Technological Disciplines, 1968-71

	1968/69				**1969/70**				**1970/71**			
Occupation	**KI**	**ON**	**NN**	**TOT**	**KI**	**ON**	**NN**	**TOT**	**KI**	**ON**	**NN**	**TOT**
Doctors	3	--	22	25	3	--	28	31	5	1	29	35
Pharmacists	5	6	--	11	5	6	--	11	7	8	--	15
Architects	-	1	3	4	-	1	3	4	-	1	8	9
Surveyors	1	-	2	3	-	-	1	1	-	-	3	3
Engineers												
- Civil	1	-	5	6	1	8	-	9	-	2	13	15
- Water	-	-	4	4	-	-	2	2	-	2	10	12
- Electrical/												
Mechanical	-	-	4	4	-	1	4	5	-	2	5	7
- Irrigation	-	-	1	1	-	-	1	1	-	-	6	6
- Agri	-	1	-	1	-	1	-	1	-	1	-	1
Agriculture												
Vet Offs	-	-	2	2	-	-	3	3	2	1	4	7
Animal Husb	1	-	-	1	3	-	-	3	3	1	-	4
Agric Offs	1	1	3	5	5	2	2	9	8	2	3	13
Pest Control	-	3	1	4	1	3	1	5	1	3	1	5
Total	**12**	**12**	**47**	**71**	**18**	**22**	**45**	**85**	**26**	**24**	**82**	**32**

KI = Kano Indigenes
ON = Other Nigerians
NN = Non Nigerians
TOT = Total
Source: Kano State 1970.

The gravity of the Kano State manpower strength reflected in Table 5.1 is emphasized when it is considered the total estimated population of Kano State at the time was over 6 million, indicating, for instance, in the case of doctors, the patient-doctor rate was far from adequate for the population of Kano State. Further, it is significant to note in every manpower discipline, there are more expatriates than Nigerians. And even then, the number of Kano State indigenes was not much more than ‘other’ Nigerians.

What was politically disturbing to the policy makers was the awareness of the vulnerability of the various development projects in Kano should all the expatriates and other Nigerians decide to withdraw their services for whatever reason - as indeed did happened during the Nigerian Civil War (1966-1970).

This situation was complemented by the general feeling among government officials in Kano that schooling was not functioning in a way which identifies with social and economic development. As a government document stated in retrospect,

> “The present acute shortage of manpower in Kano State results largely from the lack of the right kind of educational facilities. In more of our secondary schools, the available science teaching facilities, laboratories, equipments, materials compared against actual school requirements are far too inadequate. In almost all secondary schools there is a general shortage of qualified science teachers. The students going into secondary schools do not appear to appreciate the career prospects of

personnel with the needed science qualifications." (Kano State 1979b p.138).

This trend has disturbing effects on the overall economy of the Kano State government, not only in terms of contribution towards implementation of social projects, but also in its effects on the general welfare of the society where highly trained scientific and technical manpower is needed for social advancement. These thoughts were further reflected again by the Kano State government where it observed,

> "Although Secondary Education in the state has expanded very considerably over the last few years, the number of students graduating in Science and technical subjects remains a very small fraction. Our schools and universities are still dominated by the study of liberal arts. In Kano State for example in 1975/76 WASC, only 12% of our candidates took Science subjects...In 1977...it was noted that although the first indigene of Kano State in the field of medicine graduated over 20 years ago, yet the State cannot boast of more than 10 medical doctors who are indigenes of Kano State." (Kano State 1979b p. 43 and 139).

It was under these circumstances that a new Military government came to power in Nigeria in 1975. One of the first acts of the newly appointed governor of Kano State was the reorganization of the Kano State Civil Service. But because of the importance of the Ministry of Economic Planning in the implementation of the various projects in the State, its functions were further widened to include a ministerial committee called the Manpower Development Committee.

The Committee was made up 18 members, each representing a Ministry or department in the Kano State civil service. These included the State's Chief Agricultural Officer, Chief Medical Officer, Permanent Secretary Ministry of Works and Chief Education Officer, as well as the Secretary of the Kano State Scholarships Board, then Alhaji Ado Gwaram who was later to play a very central role in the establishment of the Science Secondary Schools in Kano. The Commissioner for Economic Planning, then Dr Ibrahim Ayagi was the Chairman of the Committee. The functions of the Committee included

a) assessing from time to time the manpower requirements of the State government, State Corporations, Companies, Boards or Agencies, and the Local Government Authorities, and the manpower implication of their development programmes and projects,
b) advising the State Government generally on the policies and procedures to meet the manpower requirements, and more especially, to advise the concerned Ministries, the Public Service Commission, the State Scholarships Board (and any other institution concerned with education and training programmes) on the steps to be taken to augment the supply of relevant manpower skills and
c) sponsoring and guiding surveys of available manpower stock and future manpower needs both in public and private sectors; stock and future manpower needs both in public and private sectors (undated mimeograph, Kano State Ministry of Economic Development 1976).

In the few months immediately after its establishment, the Committee concentrated on trying to determine the best ways the various development projects started could be provided with proper technical guidance. The powers to do so were already mandated to the main Ministry of Economic Planning in the development Plan which stated,

> “The Ministry for Economic Planning would expect progress reports on the implementation of the projects on quarterly basis. The reports should not merely indicate amounts spent on a particular project at a specified time, but should describe in details the actual progress made towards implementing the project.” (Kano State 1971 p. 102)

But during the meetings of the Committee in late 1975, it eventually emerged that in every project, there was a conspicuous lack of scientific and technical manpower, especially from Kano State as reflected in Table 5.1, and the agenda of the Committee began to focus on the most viable strategy for producing more technical manpower from Kano on a long term basis to enable implementation of the projects initiated, as well as provide expert leadership to the maintenance of these projects in the future. And as Dr Ibrahim Ayagi, the Chairman of the Committee recalled,

> “A member of the Committee just suggested that one of the best ways of dealing with this kind of situation potentially is to set up a Science Secondary School which will be a specialist school with nothing concentration in science training...so that instead of dissipating all resources in all the secondary schools, we would have a concentration of science students. We wanted Kano State to concentrate on the production of science students who would now go to the universities and various institutes of technology and do engineering, medicine, do all kinds of science related subjects which we were lacking at that time. We had to go abroad and recruit the people needed. We therefore saw the need for constant and regular supply of science related disciplined students. So therefore we said let us look at this idea of Science Secondary Schools.” (CTV 27/2/1986, and Interview 7/1/1987; see Appendix 5 for further information on the CTV interviews)

But the precise way in which this strategy emerged was quite spontaneous rather than structured. As recalled by Alhaji Ado Gwaram, a member of the Committee

> “Problems were identified. There was this problem of manpower shortage, problem of science based subjects, and that something had to be done about it. So ideas were floating about. We used the principle of radiation effect in education. That is from the nucleus of whatever you are doing, you can assort a group of people, say ten of them. They graduate as best as they can graduate, and then you spread them around. Now the ten will become 40, 80, 120 and anything else. So there was this idea of saying you select the best students you can, put them in one place and train them and you put a few in Medicine, a few in Agriculture, few in Vet and allied fields. And as you go along the thing is becoming bigger and bigger and over a period of 30-50 years you are likely to make a very serious impact.” (Interview 22/2/1987)

Using the argument forwarded by this principle, the Committee arrived at the tentative conclusion that extensive and specialist schooling which has to be different structurally from the existing conventional schooling in Kano State was the most viable solution, although the Committee was not exactly sure of what form it will eventually take.

But it was clear to the Committee the then existing system of schooling in Kano State was not adequate in the production of the quantity, at least, if not quality of the scientific and technical manpower required for social advancement. As Dr Ayagi further recalled,

> "We thought: what were we aiming at? We wanted Kano State to concentrate on the production of science students who would now go to the universities and various institutes of technology and do engineering, medicine, do all kinds of science related subjects which we were lacking at that time. We had to go abroad and recruit the people needed. We therefore saw the need for constant and regular supply of science related disciplined students. So therefore we said let us look at this idea of Science Secondary Schools." (Interview 7/1/1987)

These observations were further rationalized by Gwaram who also recalled that as a whole, the Committee decided

> "the best thing will be to do something about science in secondary schools. And obviously you cannot do the best in every place in all the schools we had at that time. The issue is doing something at a particular central point." (Interview 22/2/1987)

The suggestion of the Science Secondary Schools as that particular central point which will eventually emerge as strategies for long term manpower development in Kano could only have been possible if there was some basis, no matter how slim, in believing such strategy would yield the desired outcomes, or that Kano State - an educationally disadvantaged State in Nigeria - could handle such organizational concept. Certainly, the evidence strongly indicates the Science Schools project was an original idea, and not borrowed from somewhere else; its spontaneous emergence during the meeting of the Manpower Development Committee alone attests to this.

But at that time in Kano, there was a more organizational basis for building up on the Science Schools. In 1969, a regional primary science (and other subjects) teacher training project was established at the Institute of Education, Ahmadu Bello University Zaria with the assistance of UNESCO/UNICEF. This was the Primary Education Improvement Project (PEIP).

The PEIP (science) was started in 1970 following the recommendations of the Nigerian Educational Research Council which suggested the production of science materials using the "process approach" originally proposed by the American Association for the Advancement of Science (AAAS), and recurrent as a basic theme of the science curricular reform. The materials were written and tested in project schools in many parts of Northern Nigeria from 1971-1974 (Brown and Reed 1982).

The science component of the PEIP aimed at developing scientific thinking among primary school children using the inquiry approach of teaching, as advocated by the African Primary Science Programme, which was launched in Kano in 1965 (Lockard 1967); but using different strategies. As Young (1973) commenting on the PEIP stressed,

In their structured nature, the lessons differ considerably from the units developed for the African Primary Science Programme (APSP). The APSP units provide ideas for the teachers, but leave them free to interpret these ideas as they please. Most teachers here are unwilling or unable to make such interpretation. We feel therefore that such detailed guidance is essential if the teacher is to make any progress in the handling of a subject like this." (Young 1973 p.19; see also Kolawole (1978), and Oyebanji (1975).

One of the main features of the PEIP in Kano was the production of mobile science teacher trainers who supervised the project in various primary schools around Kano on motorcycles. By 1976, many such mobile teacher trainers were in operation in over 50 trial schools in Kano which, because of their emphasis on teaching science were seen as science primary schools by the Kano State government.

The overall responsibility for the PEIP in Kano was given to the In-Service Training Centre, later the Kano Educational Resource Centre. The Director of the In-service Centre at the time of the PEIP was Alhaji Ado Gwaram who was later made the Secretary of the Kano State Scholarship Board - and subsequently a member of the Manpower Development Committee in 1975. As he recalled,

> "When we were thinking of doing this (suggesting the creation of Science Secondary Schools at the Committee), we said something has to be done in the area of science right from the primary up to secondary and then of course on to the universities. And because of the commitment of the Kano State government in allowing the Ministry of Education and the In-service Centre to experiment on this science project (PEIP), we made very very serious inroads in Primary Science. Between 1972 and 1975, there is no state in the North that was doing better than Kano in the area of primary science. And through the PEIP, between 1971 to about 1975/76 we were able to establish very good science programmes in about 50 primary schools in Kano State. And I made sure that they were staffed with Grade II teachers who could handle science, they had facilities, good supervision, mobile teachers - graduates from British Universities (members of the Voluntary Services Overseas) who go on motorbikes to supervise them. We had that kind of stage to begin from." (Interview 22/2/87)

Thus the existence of this, though little known, project has provided a stimulus for considering the possibility of expanding its strategic features as basis for the production of future scientific manpower in Kano State, and interestingly enough for the change analyst, has provided an answer to the issue of carrying out trials for the new project. As Gwaram further recalled,

> "So then the thing came from the Ministry of Economic Planning saying we should do something on the base of what we (in Education) were

> doing on primary science. The strategy was the graduands of of these science primary schools have to be gotten some place to continue with science. So you select from the very good science primary schools already established under the UNESCO/UNICEF project. You select them, put them in special science secondary schools where they continue." (Interview 22/2/87)

But I must state here any possible links between the PEIP and the suggestions by the Manpower Development Committee to start a Science Secondary Schools Project was made only by Gwaram whose unique position made it possible for him to make such links. The links were not made by the Manpower Development Committee. Eventually, however the PEIP stuttered and fizzled out until it finally disappeared. As Bray explained,

> "The PEIP programme could and should have been a vehicle for considerable improvement. Unfortunately, limits were imposed on its impact by the same political and manpower constraints that caused problems elsewhere." (Bray 1981 p.110).

But it was also likely the demise of PEIP was accelerated by the appearance the Universal Primary Education (UPE) project in 1976 which, being a federal concern, overshadowed and finally stifled the more regional, but potentially powerful PEIP.

But the decision to initiate a system of schooling in Kano separate from the main conventional process with a specific focus was made possible by non-conservative membership of the Manpower Development Committee who were aware for schooling to be more productive, it has to be given a different emphasis from the conventional system.

But although the Manpower Development Committee has arrived at the conclusion that specialist training facilities were needed in Kano to produce the quantity and quality of scientific manpower needed, the Ministry of Economic Planning was not responsible for education or training. That was the responsibility of the Kano State Ministry of Education.

In the next step the Ministry of Economic Planning sent a memoranda to the Ministry of Education in early 1976 stating the observations and recommendations of the Manpower Development Committee concerning scientific manpower training and production in Kano, through as it proposed, the establishment of Science Secondary Schools with the detailed plans for such project. The memoranda was discussed at the professional level by the Ministry of Education, and according to Ayagi,

> "they came back and said they were not interested. In fact they were kind of saying well this is not your business: this is our business and we know what we are doing. So in fact the idea almost died at that time." (CTV 27/2/1986; also Interview 7/1/1987).

And because the Ministry of Education has indicated non-willingness to consider the proposals establishing the Science Schools, and since there was no other mechanism for crystallizing the idea, that, effectively would have been the end of the project in Kano.

It was at this point other, more arcane and little understood facets of educational innovations not often considered or explained by theoretical models of educational reform, began to have their influence on the development of the Science Schools, providing further insights into the mechanism of policy evolution in Nigeria.

This was because in April 1976, the Commissioner for Education in Kano resigned. The Military Governor of the State then appointed the Commissioner for the Ministry of Economic Planning, Dr Ibrahim Ayagi who was also the Chairman of the Manpower Planning Committee as the new, albeit acting, Commissioner for Education. As Dr Ayagi recalled,

> "So from April/May 1976 I was holding these two responsibilities, and of course the initial memo that I sent to the Ministry of Education (about the Science Secondary Schools) which was almost dead, was resuscitated at that time for me. But I discovered at that time there was a lot of opposition, both in the Ministry (of Education) and in the Executive Council because people were arguing that that kind of idea was not for us here. Why do you want to set up a special secondary school to cater for special students? They said it was an elitist kind of thing. What we needed to do, they said, was was actually to improve science in all the secondary schools. So that instead of having one or two science secondary schools, you will have all of them to improve." (CTV 21/2/1986)

But Dr Ayagi and others in the Executive Council who supported the idea of the Science Secondary Schools Project did not accept the rationale of this argument because as he further explained,

> "The argument of course was weak. I said things were extremely limited, the science teachers that you can find now are of course not available. They are not easy to get. It would be impossible for us to man all the secondary schools, provide excellent equipment in science, excellent teachers, and upgrade all of them. But we have seen now that education, perhaps, has to be elitist in nature because we cannot provide everybody. We don't have the resources. And therefore we have to establish specialist schools to concentrate on what you need to develop immediately." (CTV 21/2/1986)

But now having total executive control over the Ministry of Education, it became possible for Dr Ayagi to present his proposals for the establishment of the Science Secondary Schools at the Kano State Executive Council Meeting. Before presenting the idea, however, he wrote to the major universities in Nigeria with the proposal for their assessment and comments. And as he recalled,

> "We had to go to Universities, get professors to examine it and tell us what they thought about the system. They were in favour of it. That was part of the arming we had to do to get the government and to get it accepted, because with the civil service bureaucracy, the civil servants will fight anything outside it." (CTV 21/2/1986)

And even though the proposal was now firmly a Ministry of Education concern, this remained the only time an attempt to gain an academic assessment of the project was attempted. And when all the necessary, and favourable comments were received, the proposal was placed on the agenda of the Kano State Executive Council in late 1976. But it was not easy to get it accepted because of strong, and anticipated oppositions from the Executive Council generally and the Ministry of Education in particular. This was more so because of the nature of the proposal presented concerning the Science Secondary Schools.

There were four main points of the proposal. First a new body called the Science Secondary Schools Management Board should be created to implement the project, and it should be totally independent of the Ministry of Education in all aspects of its operations. As Dr Ayagi explained,

> "In order to avoid the problems of the Ministry of Education, the government bureaucracy, and to give the scheme the best chance of success, we said the best way is to take it out of the system. Not to operate it within the Ministry of Education, but to create a parastatal that would be independent of the civil service and the bureaucracy of the Ministry of Education. So that it would be on its own. It would have its own rules and regulations, about employment, about conditions of service, completely apart from the normal civil service or the Ministry of Education. We realized we couldn't get the best teachers, the best equipment under those conditions of the Ministry of Education. We therefore got it through with the normal conditions we expected to make it a success." (Interview 7/1/1987)

However, financial control of the Board will be under the Commissioner for Education (who at that time was Dr Ayagi), who has to approve its estimates before submitting to the Ministry of Finance. To provide a legal backing to this Board, a Science Secondary Schools Management Board Edict was promulgated with effect from 1 January 1977.

Secondly, the Ministry of Education should provide three secondary schools which will be converted into Science Schools. Two of these schools will be for boys and one for girls. All the schools should have Boarding facilities. This was to provide the students with full opportunities of concentrating on academic work under structured supervision. The Ministry of Education should also, in future, release any school the Science Board may wish to take over for the purposes of conversion into a Science School as part of their expansion. This was easier and more cost-effective than building completely new Science Schools.

Thirdly, the Science School students will be drawn from academically excellent students selected from Form II cohort of all secondary schools in Kano. This will be after a selection examination. This would mean the Science Schools, starting with Form III, will be Senior Secondary Schools under the newly envisaged National Policy on Education (although only implemented in 1982) which splits secondary education in two tiers of junior and senior of three years duration. At the end of the Senior year, the students will take the General Certificate of Education ordinary level examinations.

In the initial stage, each of the Science Schools was expected to have 720 students when fully operational at the rate of 240 students per year. The proposal further stipulated the teacher-student ratio should be 1 teacher per 20 students (instead of 1 teacher per 35 students obtained in conventional schools). And subsequently, each of the Science Schools should have eight laboratories (instead of the three for the main science subjects available in conventional secondary schools), two each for Biology, Chemistry, and Physics, and in the boys school Technical Drawing Studio and a Geography Room.

Finally, each student must offer the following subjects: Biology, Chemistry, Physics, Mathematics, English, Geography, Hausa Language or Islamic Religious Knowledge, and for girls, Food and Nutrition. Boys will not offer Food and Nutrition, but an elective of one from Technical Drawing, Further Mathematics, or Agricultural Science.

The Kano State Executive Council accepted this proposal with all its attendant conditions, but persistent opposition was quite strong, mainly from the Ministry of Education, which saw its power being eroded by the Science Board over which it had no immediate control. The First Executive Secretary of the Science Board (1976-1978), Alhaji Ado Gwaram, analysed the nature of these oppositions,

> "All the opposition we had in the Ministry of Education at that time - and there were very very strong oppositions - was surprisingly from people who should not oppose the idea of Science Secondary Schools at all. Their oppositions, I am sure, had nothing to do with science being anti-Islamic. I think the opposition was primarily for two reasons. One was the fact that they think we were trying to hijack some bright students from their schools and putting them in these prestigious schools - schools that one of us called elitist because he said we were only going to put the sons of who and who in the schools. That is from a fathers' point of view. From the intellectual point of view, it was only students who scored IQs this much you are putting in the schools, therefore from this level it is elitist, and they will have none of this. This, when I know very well they themselves represent elitism in this country! So the opposition was primary because of the fear of the unknown, coupled with the feeling that, and I don't like to say this, that I (Ado Gwaram) was personally associated with the project." (Interview 22/2/1987)

And to confound the situation, another dimension of oppositions emerged. This was because views started to emerge that the very concept of the Science Schools was an attempt to de-emphasize the Islamic nature of Kano State. As D S Ibrahim, the second Executive Secretary of the Science Board recalls,

> "Part of our problem was that when it was started, there were really some moves by some people who felt very strongly against the sciences; rightly or wrongly, we don't know. There were very very powerful religious groups who felt that having a school called Science School is becoming un-Islamic. That was at the early stages of the Science Schools. Their influence was through their positions in the society. Some of them are even placed in our Ministry of Education. Some of them are Commissioners elsewhere who have this myopic attitude. But we were

> really lucky to have Members of the Board who really tried as much as possible to liquidate this anti-Islamic feeling about science." (Interview 29/9/1986)

And the opposition to the project became such that Ayagi and Gwaram decided to hold a meeting in December 1977 to sell the project to the opposition. Gwaram further recalls,

> "All the Principals of the schools in Kano were called to that meeting. All the top brass of the Ministry of Education were also called. They were asking questions. I was replying. Not many people will recall the meeting, but I still recall it because it was a meeting which if you were to mention names, some of us (there) will feel ashamed of themselves, because they were really opposing. They made it personal, this terrible man Ado Gwaram is associated with this thing. If somebody else was the Secretary (of the Science Board), they would have allowed it to pass. I said look, no matter the way you churn this thing over, Kano is being served. And Kano is being served in Kano. And Kano is not only served in Kano but the over-riding future interest of Kano is being safeguarded by what we are doing. And if you don't understand now, for goodness sake just come along, and time will come when you will understand." (Interview 22/2/1987)

However, by then the Military Governor of Kano State had already accepted the proposals for the establishment of the Schools. Indeed the schools had already started functioning. As the governor announced in April 1977 during a policy broadcast to Kano State,

> "Two existing secondary schools have already been converted to schools of science. These schools will emphasize science in their curriculum so as to enable us compete favourably in gaining university places in the field of science in which were very deficient" (Kano State 1977b p.4; See Appendix 5 for the education component of the policy statement)

The establishment of the Science Schools marked the beginning of a vendetta between the newly established Science Board and the Ministry of Education, even though under the original blue-print of the idea, the Board was answerable to the Governor of Kano State through the Commissioner for Education. The oppositions to the Science Board were carried further with an attempt to make the Military Governor scrap the Science Board. As recounted by Gwaram,

> "After we had been in operation for about one and half years, the Kano State government decided to rationalize government departments and a Committee was set up. This was asked to examine government ministries, departments and parastatals and rationalize them so that where identical services are provided organizations will be merged together, to save costs in terms of manpower and finance. So this rationalization committee of course requested for list of parastatals, and the list was given to them including a new arrival called the Science Board. And they heard of the so called in-fighting in the Ministry of Education. Principals don't like the Science Board, very many people don't like the Science Board. And the fact was the Science Board was

not known, the law was not established - because all this time we were working exactly from the Council Memoranda submitted by Ayagi. So it became an easy target to scrap. Too many people were opposed to it, you see. It was providing science programme and everybody believed any secondary school can provide a science programme, therefore one of the things you can rationalize is definitely this Science Board." (Interview 22/2/1987)

That this did not happen was partly due to the influence of the then Commissioner for Education, Dr Aminu Dorayi - the only member of the Kano State Executive Council at the time with science education background (Chemistry Education) - who immediately succeeded Ayagi. As Gwaram further recalled,

"Aminu Dorayi was a scientist. He supported the idea of the science schools right from the word go. And I am telling you support was crucial at that time. So anybody who was supporting us was like a convert to Islam! So the fact that Dorayi was supportive was itself a very helpful thing to have. One, he was a science man, two, he was Commissioner (of Trade and Industries then, but immediately succeeded Ayagi in Education). So in the Council Meeting Ayagi had the support of Dorayi, because if Dorayi did not like the idea, Ayagi will have tougher time to get it through the council." (Interview 22/2/1987)

And with his new post as the Commissioner for Education, Dorayi continued supporting the idea of the project long after Ayagi has even left the Kano State civil service. The stage was then prepared for the operation of the Science Schools.

5.2 Section II: The Science Schools Board

5.2.1 The establishment and functions of the Board

Based on the recommendations of the Kano State Executive Council, the Science Secondary Schools Management Board was established in March 1977 by the Kano State government. The first appointment made was that of the Executive Secretary who, as I indicated earlier, was Gwaram and personally recommended for the post by Ayagi, who recalled the initial start as being quite difficult,

"There was no office, there was nothing! And there was no place to go, and bang, we started! And what happened was, in our first month we were operating from the Conference Room of the Ministry of Education. I had no office. I went to Ayagi and told him we needed money to get started. A cheque was prepared and issued to me in my name - Ado Gwaram - for something no one could understand, for something called Science Secondary Schools Board. Nobody knew what the Science Secondary Schools Board was up to. Very few people knew about it - the Council and myself. That had to be done that way because the moment you leave things within the civil service, they end up there. So I opened the account in my name. It was government money, but I opened the account in my name." (Interview 22/2/1987)

This was naturally without some form of resistance from the Ministry of Finance which had to approve the release of the funds. But because of the fellowship network that existed within the establishment - the then Permanent Secretary of the Ministry of Finance, Alhaji Isa Dutse, who had to finally approve the release of the funds was a personal friend to Gwaram - the new Executive Secretary was able to get the funds released. Eventually various administrative staff were either recruited or mostly enticed from other places by the Executive Secretary.

A Science Secondary Schools Management Board Edict by the Government was published and made retroactive from January 1977, although the schools were expected to start off in September 1977. The Edict formally listed the objectives and working mechanism of the Science Board as follows:

a) To provide Science Education at Secondary level
b) to set up and manage special Science Schools where the Science Education is to be provided
c) to ensure that course of instruction given in the Science Secondary Schools conform to the broad policy of Secondary education and satisfy the heads of other institutions where the students are likely to go after the completion of their studies
d) to appoint, promote, dismiss and exercise disciplinary control over its staff
e) to determine and approve schemes of service for all categories of staff and their emoluments
f) subject to the approval of the Governor, to preserve and implement conditions of service for all categories of the staff
g) to acquire any equipment, materials, furniture and other properties required for the purpose of the Board
h) to maintain premises forming part, or used in, connection with the Board
i) to prepare and submit to the Commissioner for Education an annual report on the administration and activities of the Board, and
j) to carry on all such activities and do all such things as are necessary for the good government, control and administration of the Board and the management of the assets of the Board" (Kano State 1977a p.4)

Once the Science Board was established as an administrative organization, its objectives became much more clearly formed. According to an internal communication dated 5th April 1984 which gives the details of the organizational structure of the Science Board (see Appendix 5 for a copy), the Board is vested with

> "the responsibility for providing science education at secondary level, with the following hopes and aspirations in mind:
>
> 1. that more Secondary School leavers with Science background will eventually be produced
> 2. that the majority of those so produced will proceed to higher institutions of learning
> 3. that in the long run, a crop of high level manpower (doctors and engineers) will be available

4. that the expected insignificant few that might not necessarily be doctors and engineers might find themselves in the Polytechnics for HND/OND courses in:

   i. Engineering (civil and mechanical)
   ii. Agro-allied, food technology, lab technology fields, Health and Nursing care Health and Nursing care."

It is significant to note the nature of expectations placed on the Science Schools by the government, which should provide a source of reference when discussing the extent to which the Science Schools attain their objectives, as explored in Chapter 8.

5.2.2 Membership of the Board, 1977-1979

Because of the powerful sentiments the Science Schools project generated in Kano, the choice of membership was at the discretion of the Kano State government and those directly in charge of the project. It was absolutely necessary to survival of the project to pick only those who clearly sympathized with the rationale of the project both in its initial conception and its subsequent existence. In addition, it was decided some of them should also have scientific background, although it was never made clear (both from the documents and my interviews with the key informants) how such background is expected to contribute to the Science Schools.

Because Ayagi was the Commissioner for Education then, and in keeping with the tactic of selecting only those sympathetic to the project, appointment to the Membership was at his own recommendation. He did not, however, forsee that when he eventually leaves the post of the Commissioner for Education, not all his successors will share the same degree of enthusiasm towards the Science Schools. Certainly, under the set of circumstances the Science Schools project emerged, placing the schools under the final control of the Ministry of Education (through the Commissioner for Education) has high element of risk to the future survival of the project.

Also in the directives for the membership, there were no representations from the very large Industrial sector of Kano State, any of the higher institutions of learning in the State, or, interestingly enough, the Manpower Development Committee of the Ministry of Economic Development which was the main force behind establishment of the project. These representations should help co-ordinate the output of the Science Schools with the Kano State economy, to ensure the outcomes of the project are consistent with the developmental aspirations of Kano State government.

An analysis of the first membership of the Science Schools Board for 1977-1979 shows the distribution and background of the members. The full membership was as follows:

1. Dr Sadiq Wali, Chairman (Ahmadu Bello University Teaching Hospital)
2. Dr A T Abdullahi, Member (Principal, Kano Polytechnic)
3. Alhaji Ali Mukhtar, Member (Chief Pharmacist, Murtala Muhammad Hospital, Kano)
4. Alhaji Imam Wali, Member (Director of Education, Ministry of Education, Kano)

5. Alhaji Adamu Ilyasu, Member (Principal, Government Secondary School, Birnin Kudu
6. Alhaji Dahiru Ibrahim, Member (General Manager, Nigerian Television Authority, Kano)
7. Alhaji Ado Gwaram, Executive Secretary

Thus in the first Membership of the Science Board, three members had scientific training. First was the Chairman, Dr Sadiq Wali who was at the time a lecturer in the Faculty of Medicine, Ahmadu Bello University, Zaria (and, importantly, became the Kano State Commissioner for Health in 1979). Then Dr A T Abdullahi, a Mechanical Engineer who was the Principal of Kano Polytechnic (who also became a Commissioner for Works and Housing in 1979, and Commissioner for Education in 1983), while Alhaji Ali Mukhtar was at that time the Chief Pharmacist of the Murtala Muhammad Hospital in Kano City. Alhaji Imam Wali, the then Director of Education, later became the Commissioner for Education in 1984.

The rapid mobility of this initial membership up the ranks of the Kano State civil service was the major factor that kept the flame of the Science Schools project going, because as Ayagi recalled,

> "The first Chairman was Dr Sadiq Wali, a science person, Dr Abdullahi who was a Commissioner later was also a member, and that had good repercussions later, because during the political days (1979-1983) the idea would have been killed again, if not for the fact that we had these people who had become Commissioners in the State." (CTV 22/2/1986)

Another, very significant feature of the Membership of the Science Board at this time was its fellowship linkage. As Gwaram explained,

> "It was a collection of committed Kano indigenes, working as a team because we all knew ourselves and everybody knew who was on the Board of Members. There was no question of suspicion. For example the Ministry of Education representative was Alhaji Imam Wali (who was the then Director of Education). He knew me right from infancy. And the Chairman, Dr Sadiq Wali was not only a personal friend, but also someone who knew what I could do, and he knew I had confidence in him, absolutely that much." (Interview 22/2/1987)

Thus negotiating from their status as powerful members of the Kano State civil service, as well as being close friends, the first Members of the Science Secondary Schools Management Board were finally in a position to start off the Science Secondary Schools Project in September 1977.

5.2.3 Autonomy and control

From the way the Science Board eventually evolved, an uneasy relationship was established between the Science Board and the Ministry of Education. The Board had autonomy in virtually all aspects of its activities except the most crucial - financing. Although it was deemed an independent parastatal of Kano State government, subsequently after its establishment the Board had to request for funds from the Ministry of Finance through the Ministry of Education, and this, naturally, was not without consequences.

For instance, on 17th November 1978, the Board sent to the Permanent Secretary Ministry of Education for the attention of the Ministry of Finance, its advanced proposals Recurrent Estimates for 1979/80 in accordance with the stipulation of its charter. The Board insisted

> "the estimates have been worked out to the barest minimum needs of the Science Secondary Schools Management Board, bearing in mind the financial position of the State Government. The Board's request of N1,428,810 was slashed down to N750,000!" (Kano State 1979b p. 150)

And as the student numbers in the science schools increased,
along with the number of teachers, demands for facilities to cater for them also increased - putting financial strains on the already existing resources.

But the subsequent funding of the Science Board, despite increase in the student population over the years did not increase; if anything, it significantly decreased, as seen in Table 5.2 which shows the financial expenditure to the Science Schools by the Board based on the overall funds the Board received from the Kano State government.

Table 5.2: Science Board Expenditure on the Science Schools, 1977-1986

Year	Amount (N)
1977	400,000
1978	370,860
1979	355,554
1980	398,613
1981	509,258
1982	637,590
1983	379,350
1984	509,850
1985	679,488
1986	626,265

(Source: Kano State 1979b, 1986b and the Science Board 1987)

As the allocations show, over the years since the establishment of the Science Board, it has not been possible to maintain fixed subvention for the Science Schools. However, the sharp down turn of the Nigerian economy, and the depreciating Naira value has made later financial allocations less substantial in real terms, than at the initial stage of the project. This has consequences in the ways the project is implemented (see Chapter 7).

5.2.4 Membership of the Board, 1979-1983

In February 1982 during the civilian administration in Kano, the structure of the Board was significantly altered when the then Kano State House of Assembly converted the Science Board edict into a Law, creating a Science and Technical Schools Board (Kano State 1982; a full copy of the Law is reproduced in Appendix 5). But the relationship between the Science Board and the Ministry of Education was taken to new heights with this development. The Ministry was asked to transfer all Technical and Vocational Schools under its control to the now Science and Technical Schools Board; but the Ministry of Education was also given the responsibility of carrying out all Capital expenditure projects from the Science Board.

But the most interesting development of the Science Board at this stage was there were no Board Members. The first Board membership lasted for three years (from 1977) till 1979 when the Civilian administration took over in Kano. Although the Board membership was dissolved, no new members were appointed by the new civilian administration. The Board, controlled locally by the Executive Secretary, decided to create Committees to enable it to make decisions concerning its administration. The decisions of the Committees were sent to the Commissioner for Education for ratification and approval. As the minutes of the inaugural meeting of a new Board on 23 January 1985 stated,

> "Committees were set up to tackle various aspects of the Board, to advise and recommend appropriate decisions. In the absence of the Board members, the Hon. Commissioner and Permanent Secretary Ministry of Education usually ratify the committees recommendations/decisions."

This turn of events put the Science Schools effectively under the control of the Ministry of Education, although the Director of Education at the time (1984) was Alhaji Imam Wali - a first generation member of the Science Board, and very sympathetic to the project from accounts of key informants, especially Alhaji Ado Gwaram.

There were five of these committees, including the Staff Development and Training Committee, Senior Staff Establishment Committee, and the Academic Committee the latter of which is more relevant to understanding the dynamics of the Science Schools project in its academic dimensions.

The Academic Committee was responsible for monitoring the performance of institutions under the Board, standardization of textbooks and other teaching equipment. It was also responsible for the selection of candidates into the Science Schools. It is the only committee whose functions are geared towards the provision of any professional services for the Science Schools.

These Committees run the affairs of the Board under the control of the Executive Secretary. By then Gwaram had already left the Science Board and another Executive Secretary, D S Ibrahim was appointed. Commenting on the survival of the Board at this time (1979-1984), Ibrahim attributed this to the strength of the composition of the first Board membership. As he explained,

> "We withstood the test of time. When we started we had people like Dr Sadiq Wali, Dr A T Abdullahi, and Alhaji Imam Wali. All later became commissioners in Kano State. When the PRP (Peoples Redemption Party, the main, but not only, political party in Kano) came, with two young commissioners in the person of Dr Wali who was made the Commissioner for Health, and Dr A T Abdullahi who was made Commissioner for Works and Housing, you see we were in business. We had at least two big or very good Members (of the Board) who would do anything to ensure that the Board, or the nobel idea (Science Schools Project) continues. Now when PRP came there was all sort of oppositions and problems. But these people (Wali and Abdullahi) were

able to convince the Governor that this idea should not be dropped for whatever reason." (Interview 29/9/1986)

And when Dr Ayagi left as the Commissioner for Education, his immediate successor in 1978, Dr Aminu Dorayi, was also sympathetic to the project. Dorayi's support has already been outlined by Gwaram earlier. Ibrahim places the situation in a context:

> "I wouldn't call the relationship between the Ministry of Education and us very cordial, although it depends on the specific time you were talking about. When Dr Ayagi was the Commissioner for Education (1976-1978) it was fantastic, because he was one of the policy initiators of the Science Board. When he left, came Alhaji Abdulhamid Hassan who was a strong opponent of this Board. He felt, as he felt strongly then, that it was a useless project. He was a personal friend of mine. He was my Commissioner. He called me. He said look I am taking you away from the Science Board. You are just wasting our resources. I am going to give you another job in which I think you will contribute much more to Kano State than just wasting time on the Science Schools!" (Interview 29/9/1986)

But after Hassan, Dr A T Abdullahi - a former member of the Board - was made a Commissioner for Education in 1983,

> "...So we were back in business! And by time Dr Abdullahi exited in 1983, we had already made our mark. So you can't just do anything to the Science Board now! If not for him we would have been scraped. Oh yes, I know for sure that we were up against a herculean task against people who felt that we were just wasting public funds on a useless venture." (Interview 29/9/1986)

Thus power struggles, fellowship network interactions and personal interests all emerged as the vital ingredients that ensured the survival of the Science Secondary Schools Project in its infancy. The intellectual validity of the project was never made a focus of attention by either proponents or antagonists of the project. Nor were concerns expressed about the academic emphases of the Science Schools.

5.2.5 Membership of the Board, 1984-1986

The various Committees established within the Science Board, in the absence of the full Board Membership, run the affairs of the Board until December 1983 when there was another, Military, change of government in Nigeria (the third since the establishment of the Science Board; and since the proposal for the Science Schools from the Manpower Development Committee in late 1975, five Commissioners of Education had been appointed at various times in Kano to 1984).

But it was only a year later, in December 1984, when the new military governor of Kano State appointed new members to the Science Board and control of the science schools returned firmly to the Board. The new Board membership had the following composition:

1. Dr. Yahaya Mohammed, Chairman (Chief Medical Officer, Murtala Muhammad Hospital, Kano)
2. Engineer Ibrahim K Inuwa, Member (National Truck Manufacturers Company, Kano
3. Alhaji Umaru Abdulkadir, Member (Pharmacist)
4. Alhaji Abdullahi Getso, Member (Businessman)
5. Alhaji Usman S Dare, Member (Retired Headmaster, Gumel)
6. Alhaji Abdullahi Umar, Member (Centre for the Study of Nigerian Languages, Bayero University, Kano)
7. CIE TSS/Tech Representative Member (Ministry of Education)
8. Alhaji Aminu G. Bichi, Executive Secretary

By this period membership has ceased to be based on evaluation of a potential members' sympathy towards the Science Schools. Other, quite vague and little defined criteria for membership became established. Thus this membership, evolving out of a totally different political climate, did not share the same camaraderie as the first, but it is included here to point to the general trend of membership of the Board which was to become a pattern in the future. But significantly, the new Commissioner for Education in Kano (sixth since initiation of the project) after Dr A T Abdullahi in 1984 was Alhaji Imam Wali - a founding Member of the Science Board. Thus the interests of the Science Schools were protected under whatever system of government operated in Kano State for the first ten years of its life through fellowship network system that operated especially among the first generation Board members [8].

An interesting development of the Board Membership since inception was the marked absence of women as members. I raised this issue with the policy initiator of the Science Schools Project, Dr Ayagi who admitted he was aware of the situation, and added

> "...but you know we were concerned with practical problems, not political. I mean considerations about women and so on is political." (Interview 7/1/1987)

No further explanations could be given as the emergent view clearly was women have no significant role to play in dealing with "practical problems" such as science education change strategies. With this attitude, it becomes therefore difficult to present the case for women science education effectively in this context.[9]

This membership of the Board (1984-1986) did not remain for long, however. In August 1985, there was yet another military coup in the country (the fourth change of government since initiation of the project in 1975). Some six months later, on 24th January l986, the new military governor of the State dissolved the Science Schools Board.

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[8]. Of further interest in illustrating the fellowship network interactions system in the case of the Science Schools project was the appointment of the Executive Secretary of the Science Board, Alhaji Aminu G Bichi to the post of Kano State Commissioner for Education in April 1988.

[9]. However, a woman dentist was made a Member of the Science Board in 1987. She was Hajiya Sha'awa H Sai'd.

But by 1984, the issue of who supports or who opposes the Science Schools project in Kano State has ceased to become a major source of concern to the survival of the Science Schools, because around the period other more important issues connected to the Science Schools started to emerge. All these deal with the outcome of the project, which I will discuss fully in Chapter 8.

And since the Science Board has various committees as part of its permanent structure it simply reverts to these Committees in the absence of Board Members. The third (and current during this research) Executive Secretary of the Board, Alhaji Aminu Bichi attributed the longevity of the Board in the face of constant changes in leadership in Kano quite simply to luck. As he explained,

> "I think luckily enough we are the least affected by changes in government. In every government in every where in the world, you cannot dissociate politics and education. New rulers come in with new philosophies and new ideas. Every government has its own ideas and policies on education and they keep changing. I mean if another government had come in and said okay Kano State is no more interested in placing high premium on science and technical education, then this Board may not be favoured. And one thing why I said we are lucky is we had had very little interference from government; in particular if you look at me sitting here: I have been sitting here for six years (1980-1986) which is very abnormal in government - any form of government." (Interview 23/9/1986)

Thus economic and political priorities emerged as the main factors in the genesis of the Science Schools project. In all the policy process, the academic priorities of the Schools was never made part of the agenda.

5.3 Section III: The Science Secondary Schools

5.3.1 Initial preparations

The schools selected for conversion into Science Schools were the secondary schools at Dawakin Kudu (originally established in 1975), and Dawakin Tofa (1972). Each of these schools was well built and located in a pleasant rural pasture land. The Dawakin Kudu School was also relatively new at the time (1977) and built with financial assistance from the United Nations Development Project. But most significantly, both were exactly the same short distance away from Kano metropolitan (32 kilometres). This was important to the planners of the Science Schools project because they do not want to locate the schools too far from Kano which will make them unattractive places to work for teachers, especially expatriate staff. As the First Executive Secretary of the Science Board explained,

> "The two schools (Dawakin Kudu and Dawakin Tofa) were selected because we wanted schools that were very close to Kano, where we can literally leave office now and get there within the next twenty minutes. And we needed centres where you can put international staff without them having to worry about coming to Kano. We also needed easy access to Kano because we thought if our laboratories could not operate we bring our staff and students to laboratories in Bayero University (in

> Kano) - because we were not prepared to allow anything to stop us from operating.” (Interview 22/2/1987)

This statement underscores the sheer determination behind the efforts to see the Science Schools have started functioning, despite all the opposition provided to the project by the Ministry of Education.

5.3.2 Fundamental characteristics I: The students

There was no area in the establishment of the Science Schools in Kano that has created more controversy with both Principals and civil servants than in the selection of the students for the Science Schools. This stemmed principally because, as one expatriate former teacher in a Science School puts it, “the Science Schools poach students from other schools.” Under the standard procedure, students considered academically good in Form II in all secondary schools in Kano (owned by the Ministry of Education) were given a selection examination and those who passed taken to the Science Schools where they continue with Form III.

The decision of the Science Board not to use the Kano Educational Resource Centre, which is the main professional and advisory unit for educational affairs in Kano State, to design its selection examinations for it, even though KERC was represented in the selection committee (see below) did not help matters much. As the Executive Secretary explained in an internal communication dated 23rd March 1977,

> “The two Science Secondary Schools at Dawakin Tofa and Dawakin Kudu are supposed to start operating as Science-Oriented by September 1977. It is agreed that the students to be admitted will be selected from Form II of all the existing secondary schools in the State.
>
> “The selection exercise is central to both the success of the end-products and the image of the Management Board. Needless to say, the selection techniques/procedures must be scientific and comprehensive. Tests/exams/interviews should be carefully planned and well-executed so that the outcome ca be a professional foundation for successful training edifice.”

To ensure the selection of the students is carried out along the lines envisaged by the Board, a sub-committee was set up called Tests Committee which will work on the selection process for the two schools. This Committee gradually metamorphosed into the Academic Committee (in 1979). The Selection Committee was composed of the following, each represented by a Member:

a) The Science Secondary Schools Management Board
b) The Ministry of Education/In-Service Centre (which later became the Kano Educational Resource Centre)
c) The local branch of the Science Teachers Association of Nigeria (STAN)
d) Any other body/person the Committee may wish to invite to join.

The main tasks of the committee will be to:

a) examine contents and format of the selection procedure
b) the time (month/date) the selection is to be made

c) examine related problems of the selection, including marking of tests, etc.

The attempts to include the Science Teachers' Association of Nigeria in some activities of the Board would seem to indicate the latters' commitment to ensuring full professional participation of the science teachers in the affairs of the schools, although this remained the only time the STAN was consulted in any subsequent affairs of the Science Board.

In the end, the Board also used the WAEC to conduct selection examinations for the schools until when the Board itself could do such task. As the Kano State government explained in 1979,

> "The Science Secondary Schools Management Board has for the past three years (i.e. since 1977) been using the services of the West African Examinations Council for conducting aptitude tests for entrants into the Science Schools" (Kano State 1979b p.161)

5.3.3 The Student Selection Process

Despite being established under an atmosphere of constant opposition, high expectations about the number of students who will eventually benefit from the establishment of the Science Schools in Kano were maintained by the Science Board. As a Kano State government document explains,

> "Each Science Secondary School is expected to have 720 students when it is fully operational...The five year objective (from 1980 when the students in the schools take the WASC examinations for the first time) of the Science Secondary Schools Management Board is to produce the following number of WASC boy students with all the required science subjects for direct entry into University or Polytechnic for professional courses in the sciences:
>
> a. June 1980 - 217 students
> b. June 1981 - 254 "
> c. June 1982 - 360 "
> d. June 1983 - 480 "
> e. June 1984 - 480 "

Total - 1791

> "It is also envisaged, that funds being available, the Board will produce by June 1984, 624 WASC girl students with all the required Science subjects for direct entry into University, ATC, Polytechnic or School of Nursing" (Kano State 1979b p. 162).

However, in the subsequent years, the population of examination entrants from the science schools turned out to be less than the projections of the government due to natural waste and incidences where students were dismissed for various (but mainly disciplinary) reasons, as shown in Table 5.3 which indicates the number of West African School Certificate Examination entrants from the three science schools from 1980 to 1985. The figures are placed along side the projections made by the government.

Table 5.3: Science School Graduates, 1980-1985

Year	Projected	Actual
1980	217	183
1981	254	226
1982	360	316
1983	480	296
1984	1104	439
1985	2000	514
Totals	**4415**	**1974**

(Source: Kano State 1979b; the Science and Technical Schools Board, 1987)

The system of selection - which was crucial to the Science Schools - was not without its problems and issues; and a detailed analysis of its initial mechanism revealed insights about its nature and enables further understanding of the reception of the Science Secondary Schools project in Kano State.

On 20th December 1978, the then expatriate Principal of the Dawakin Tofa Science Secondary School, Mike Douse sent a memo to the Board providing what were the first clear guidelines concerning the method of selecting students subsequently for the science schools. The first strategy advocated was publicity. In this, it was suggested,

> "We should design a poster, two or three copies of which should be displayed at all post-primary schools in the State. It should state clearly the purpose and nature of the Science Secondary Schools, correcting current misconceptions. There should be a couple of good photographs and the presentation should be attractive. Similar information and images should be made available through newspapers, radio and television. Every prospective student should know of and be excited by the possibility of being selected to attend a Science Secondary School."

Some students who have already heard of the Science Schools apparently applied to them directly for admission, since the memo stated

> "Already we have written suitable letters to a dozen or so boys who have 'applied' to us: such correspondence should not be ignored. And all of our boys have volunteered to urge intelligent relatives and friends (in Form 2) to aim at joining us. Our present students are our best ambassadors."

It is significant to note only boys have shown interest in getting into the science schools. However, preparation for girls science schools were already being considered at time, and will be eventually discussed in the next sub-section.

The memo also indicated its awareness of the possible problems the selection process was likely to face, especially from the Principals of the feeder schools, by stating

> "Apart from endeavouring to ensure that Post-Primary Principals display the proposed posters, we need to think hard and how best to persuade them to endeavour to send us their top pupils: some task!"

The persuasive strategy suggested was to draw attention of the government involvement in the establishment of the Science Schools, thus emphasizing its legislative nature. For instance, concerning the ways of convincing the Principals of the feeder schools, the memo added

> "However, it is (a) government policy and (b) in the students' own best interest for them to lose their ablest and these points should be made unequivocally. In addition, we should think of ways of bestowing public praise on schools succeeding in getting several students through our selection: a good post-Primary schools is one that manages to get several students into Science School! If we cannot meet with all Principals before hand, we should at least ensure that all correspondence with them enhances our chances of getting co-operation. Otherwise the whole entire exercise will fail."

And due to the legislative nature of the project (which reflected government machinery at the time), Principals were not consulted at any stage of the development of the Science Schools in Kano. This lack of consultation might have further contributed to the reluctance of some Principals to co-operate with the Science Schools Board. This situation was not improved for the Principals, especially with the further suggestion of the memo

> "...So I strongly urge that 'someone' visit all of the feeder schools in January, doing the necessary public relations, but also, with the Principal, choosing the boys to be considered. There must be access to examination records and an opportunity to talk to teachers. This would take place before the initial tests and we would be greatly suspicious - and do something about it - if either (a) top students did badly in the tests, or (b) a school failed to get anywhere near its quota."

This quota referred to the minimum number of students required and the emphasis was "the vital thing is that we get the 'best' 48 or 55 or whatever."

The memo expressed dissatisfaction about the outcomes of using the services of the WAEC which were used for the first set of students (1977)

> "The overall process has certainly provided this school with a number of duds and I am afraid WAEC sees us as an interesting little experiment and pays little attention to our actual needs or to the non-academic potentialities of the situation."

It is significant here to note an expectation by the Principal that not all students who came to science schools would proceed to an academic future. These observations led to a suggestion for a more school based test which the Board can design to suit its specific needs as far as the science students are concerned. As suggested in the memo,

> "If I was devising an initial test from scratch, I would include two 1 hour papers:

> a) A very stiff and practically non-verbal mathematics test; and b) A written comprehension test based upon passages dealing with scienceconcepts; simple, non-specialist vocabulary, objective questions.
>
> I do not think that the multiple-choice science tests used thus far are of any value. At best they test how well a boy has been taught - and we are after potential. And the test is dependent upon specific vocabulary (habitat, aquatic, convection etc). What we want to assess is a boy's interest in, and capacity to grapple with, scientific ideas."

And in order to ensure only the selected students did eventually get into the science schools, a rigorous system of identification of students was suggested. This was that

> "Candidates must be told to retain precisely the same names throughout the selection procedure. They must sign each examination paper and give key personal details. At interviews, they must sign again and the interviewers must check the personal details (e.g. mother's name, primary school attended). On gaining admission the students must sign and submit to checks one more. This rigorous procedure is advocated because of my suspicion that several of our present students are here under false pretenses: about six of them cannot yet write sentences in English and could never have passed any kind of ability or content test in their lives."

The Board responded to these suggestions immediately. On 24th January 1979, a form letter was sent to all the Principals in Kano State secondary schools reminding them of the existence of the science schools as well as summarizing the objectives of the schools. At beginning of the letter, the Board tactically pointed out

> "The Science Secondary Schools Management Board was created by the (Kano) State Government to provide Science Education at Secondary level..."

This information, coming as it did - during one of the more remarkable Military regimes in Nigeria - could not fail to yield some measure of co-operation from the Principals. The information also ensures the Board absolves itself of any blame of the effects of the selection procedure since it is set up to carry out the directives of the Government of Kano State. The letter added,

> "It is hoped that all deserving Kano State pupils in Class II with an aptitude and ambitions in the Sciences be given these opportunities, and your co-operation is requested to publish the attached Information Sheet on your students' Notice Board"

However, the way the information was communicated, especially to the students also must have left the Principals of the feeder schools a trifle uneasy. The information sheet was done in the form of a questionnaire which is reproduced in Appendix 5.

The selection process is crucial to the entire Science Secondary Schools project for a number of other reasons. When the science schools were established, it was envisaged they will fit in with the new National Policy on Education (which was expected to be implemented in 1977) making them senior secondary schools.

Under this original conception, the students were to have been graduates of the junior schools and thus the issue of "skimming" students would not have arisen as they would have finished junior schools anyway, and are ready to go to senior schools. If the new education policy had been implemented at the time it should have been, which was 1977, or at worst, 1982, many of the problems of the science schools which surfaced later in the selection process would have been eliminated.

However, the policy was delayed for various reasons until September 1982; this meant students from the Science Schools from inception of the project came from the Form II population of the nonscience schools - and the system of selection ensured only those considered the best were accepted for the science schools. This was a situation that left many of the schools uncomfortable. As the Principal of a feeder school explained,

> "Believe me, not me alone but many people, the teachers, you see are grumbling that the best students have been taken away and as such nobody should blame us for having very bad students, because the best ones who could help the remaining who are not as good as these ones have been taken away. There is nothing we can about this. This is a government project and they can do whatever they want." (Interview 30/9/1986)

The possibility that the selection process could be influenced in favour of certain socio-politically powerful groups in Kano was raised with the officials of the Science Board. It was made clear that selection of students to the schools was based purely on merit and passing the examination. As a former Executive Secretary of the Board elaborated,

> "No, No way. Okay there may be one or two cases, but the majority had to go through the grind. If a child cannot make it, he will be the first ask his parents to remove him, because he will be the laughing stock of these geniuses; you know how they are. Children will always be children and if you don't make up you are in trouble with your colleagues. So we are very lucky in that aspect in that even the people who think that coming to the Science schools meant a lot to their children later change their minds because of what they heard (about the demands in the Science Schools)." (Interview 29/9/1986)

After the initial selection exercise in 1977, the first set of 240 students was selected from 22 secondary schools in Kano. A total of 120 students were sent to each of the then two Science Schools in September 1977. Subsequently, however, some of the Principals in the feeder schools responded to the situation by substituting their best students for the less than average which were requested to sit for the selection examination. The Science Board discovered this quickly, though, because as a Principal said,

> "We cannot even substitute good students for bad students during the selection. These people come from the Science Board and they try to examine the files of my students and they may like to see my students physically. We have to be honest in this. The question of my opinion (as a Principal) does not arise because nobody will ask for my opinion: do I like it or not? No, nobody will ask me. This is an annual event, you know. Every year there will be a letter from the Science Board telling us that there is going to be a selection exercise. And then there are many students who would like to go to these schools because they feel that the science secondary school is better than any school in which they are." (Interview 30/9/1986)

In their objections, the Principals of the feeder schools provided two arguments to support their case. First, if their best students were taken away from them, then only the worst students were left behind. And if the GCE ordinary level examinations were bad, the schools will be blamed; and this is more since the some states in Nigeria started grading Principals according to the GCE results. If this practice spreads to Kano, it is likely to have some unpleasant consequences for the Principals.

Secondly, some Principals argue if it is true the Science Schools are special in the sense of having better equipment and teachers and other facilities, then in makes more sense to select not the best students from the feeder schools who, if they are good anyway would succeed no matter where they are. It therefore makes more sense, according to this argument, to take students who are less than average, but very likely with latent abilities in science and allow the good environment of the Science Schools to develop it. In this way, the conventional schools will develop their good students, and the Science Schools will enable students with latent abilities in science to manifest themselves to the benefit of everyone. But Ayagi discounts these arguments by pointing out,

> "The system was not supposed to drain the schools of the best students. We are concerned with the students with a natural endowment in science. The teachers should not be feeling they have lost their best students unless you are saying only science students are the best. But of course that is not so." (Interview 7/1/1987)

A possible solution to problems associated with the selection procedure may be found with the implementation of the new senior secondary school segment of the National Policy of Education in September 1985, but only in schools that were distinctly separated as Junior and Senior Secondary Schools. This is because from 1985, students for the Science Schools (which are Senior Schools right from the beginning) will be coming from the Junior Schools. But if the Junior School is still part of a comprehensive school which includes a senior section, as many of the Schools still are, then the problems posed by the selection exercise may remain for quite a while.

This is because some Principals of the Science Schools argue because of the pioneer status of the Junior Schools, most of them were no better off than primary schools (actually a lot were converted primary schools) and as such quite inadequate for providing the full range of instructions, especially in Integrated Science. This will mean such schools will not be considered suitable for selection exercise by the Science Board. The Board would rather get its students from established schools. And unless the situation resolves itself, such schools will continue resisting the selection procedures.

Thus the lack of thought-out working link between the Science Schools project and other educational services and contexts in Kano, have further contributed to a considerable amount of difficulty in stabilizing the project, especially after a shaky start.

In subsequent years, the overall method of selecting the students for the Science Schools was modified and the Academic Committee took over the process of admission. And because over the years when the project was just getting started the presence of many students who the Board felt could not have been the best ones from their schools became evident, the Science Board adopted a policy of returning students who did not make it in the Science Schools to their former schools to study arts. This decision was communicated to the Principals of the Science Schools by the Science Board on 29th September 1983 where it stated,

> "In pursuance of the objectives for which it was established, the Science and Technical Schools Board decided, that with effect from the 1983/84 school year, any student who is identified to be academically unable to pursue the three year GCE O level programme in any of the Science Secondary Schools will be transferred back to the school from which he was selected. This decision should be communicated to all students and parents concerned. Copies of this circular will be sent to other bodies and Institutions concerned."

And by then some form of arrangement has been worked out with the Ministry of Education which will enable the Principals of the its schools to accept, as it were, the rejects of the Science Schools.

But in order to give the students who were selected to the Science Schools, a chance at surviving the Science Schools experience, the Science Board adopted a strategy of differential criteria in admission based on the students' residential background (urban/rural axis). The Academic Committee at a Board Meeting held on 24th July 1985 reported that the following criteria were used in its final selections for the 1984/85 intake into the Schools:

> "1) Male candidates in schools outside Municipal Kano were selected on the basis of gaining 40% and above in the entrance examination plus interviewers recommendations. 2) Male candidates from schools within the Municipal were selected to go into the Science Schools on the basis of gaining 53% and above in the entrance examinations plus interviewers recommendations. 3) All female candidates were selected on the basis of gaining 30% and above in the entrance examinations plus interviewers recommendations."

It is interesting to note the special preference given to girls in the admission criteria - which substantially lowers their admission grade as against the boys. This provides a basis for considering the girls science school.

5.3.4 The Girls Science Secondary School

In the initial preparations and selection of students, the decision taken by the Board and contained in an internal memo dated 23rd March 1977 was "for the time being, attention should be directed to selection from Secondary (Grammar) Schools and amongst boys only." This is not to indicate although women were not part of the policy decision to set up the project, the science education opportunities made available to the boys will not be made possible to girls. Certainly, the radical forces that made the very concept of the Science Schools possible in an orthodox culture such as Kano, could also precipitate the conception of a girls science school. However, there was a delay in starting the Girls Science School because although,

> "The Science Secondary School Management Board has plans to open a Science Secondary School for Girls...due to financial constraints and the inability of the Ministry of Education to hand over one of its schools (this was not possible)" (Kano State 1979b p. 161)

But during the civilian administration (1979-1984) the Board was allowed to start Science School for girls which was initially planned in Bunkure, but later changed to Taura. The Board had wanted to take over Girls Secondary School Kura for conversion to the Science School for Girls, but this was resisted successfully by the Ministry of Education. The eventual acquisition of a site at Taura to build the new Science School, indeed reflected a further example of the fellowship network that ensured the survival of the Science Schools project. This is because when the Ministry of Education refused to allow Kura to be converted to a Science School, the then Commissioner for Education (1982/83), Dr. A T Abdullahi, a first generation member of the Science Board intervened and made the establishment of the Girls Science School possible. As the Technical Adviser of the Science Board recalled,

> "We felt all along that we should have started a girls and two boys Science Schools. But we had trouble with the Ministry of Education. We wanted to take Kura girls secondary school; they refused. So we had a lot of problems. In fact it is through the Commissioner for Education, Dr A T Abdullahi that we acquired the site at Taura for the girls Science School, otherwise it would have been impossible." (Interview 29/9/1986)

The Girls Science Secondary School was officially started in September 1981. It was, like the overall concept of the Science Schools, the first of its kind in Nigeria. It was supposed to be located at Taura, in Ringim local government, some 93 kilometres from Kano. But because at that time the school was still being built, the science students were temporarily placed in spare classroom in Government Girls Secondary School Kura, and treated separately from other students.

They stayed there up to the end of 1984 when they moved to their own school at Taura in January 1985. During their stay in Kura, two sets of students were presented for the GCE ordinary level examination. A total number of 129 students have taken the GCE examination since 1984, which is a shortfall from the 624 students projected by the Science Board.

The science school for girls appears to be unique because it was the first time the Kano State government (or any other arm of the Nigerian government) has made such explicit statement about the science education of girls. The school therefore appeared revolutionary arising out of social context where general modern schooling for girls was not openly encouraged.

But the most surprising development about the girls Science School was some Principals of some girls schools were against it; and registered their feelings, like their male counterparts, by first of all not allowing their own students to take the selection examination of the Science Board, and secondly, in cases where the students were allowed to take the selection examination, by not releasing the girls to attend the Science School. Matters reached a head when the Science Board complained to the Permanent Secretary, Ministry of Education Kano on 4th February 1985 in a communication where the Board stated

> "....three weeks after the opening of science Secondary School, Taura, some principals of girls institutions are yet to release their students to report to the school. This shows that some principals are not cooperating with the Board on science schools programme. (The Principal of....) is particularly noted for this, for she even refused to allow her students to sit for the science secondary schools entrance examinations. It has come to the Board's notice that the Principals of...(5 schools)....are yet to release the students who were selected for Government Girls (Science) Secondary School, Taura. The Principals of......(3 other schools)... are yet to release one or two of their students to report to Taura."

What is surprising about this is the Principals' unwillingness to participate in the scheme, the argument being they should be the first to demand equal opportunities for girls in science - especially in a place such as Kano where very few girls are encouraged to attend modern schools. It should have been expected those few who do show inclinations towards science (certainly an unusual occurrance for girls from Kano) would be encouraged by their own Principals. The fundamental principle behind the science schools is the belief that the Science Schools, being specialist, may cater for the needs of the students in science more than in normal schools. Consequently, the chances of those students in pursuing scientific careers are thought to be higher in the Science Schools.

A further observation is women such as the Principals of the schools who refused to allow their students to go to the Science School, being educated in the modern sense, are expected to be more liberal in their attitudes to female schooling. Thus their opposition, as in the case of their male counterparts, underscored their uncertainties about how the girls Science School will affect them personally, rather than a reflection of their professional concern about the quality of education in their schools.

But not all Principals opposed the girls Science School. As a female Principal in a (prestigious girls) nonscience school rationalized,

> "I know quite a number of Principals do not like the idea of the Science Board selecting their best students. But as far as I am concerned it boils down to the same thing. You are educating these students for the state and the country at large. So it doesn't matter whether they are here (in a

> nonscience school) or at Taura. It is the same thing. Moreover, I feel with the Science Board, the girls have a better chance at science education." (Interview 15/10/1986)

Right from the time the science school for girls was established, the Board made it clear that provision in the school would be along the same line as in the boys schools. The only discrimination - it may be labelled that in another perspective - was in the range of subjects offered to the girls. They have all the subjects offered to the boys except Further Mathematics, Agricultural Science and Technical Drawing; although Food and Nutrition is compulsory for the girls, and it is not taught to the boys.

5.3.5 Fundamental characteristics II: The teachers

In the initial stages of the project - with a buoyant economy - the Science Board recruited its science teachers from US and UK. Alhaji Ado Gwaram, the first Executive Secretary headed the recruitment team. As he explained, there was a definite strategy in the choice of main officers of the schools which was based on his own specifications. For instance, the Principals for the Science Schools

> "...must be Americans. Oh yes, because my own feeling was we were talking about science education. America at that time had gone to the moon. Their science matched even the Soviet Unions'. So if you are talking about modern science, the pragmatic way you can approach it is you go to America. So we said there will be two principals and they have got to be Americans. And I made up my mind they have got to be Americans." (Interview 22/2/1987)

This rationale is the nearest the Science Schools came to being identified as part of the science curriculum reform movement by those who initiated the project (it may be seen as that), even though no awareness of the reform movements was acknowledged by the officials. It is therefore interesting although the Science Schools project was entirely a local concept, it was only when it came to being operationalized that outside expert assistance in science education was sought. Curiously enough, the Science Board wanted the British as the Heads of Departments. As Gwaram further explained,

> "Then I said these schools are going to have heads of departments. So what we should do is, the Heads of Departments for Physics, Chemistry, Biology and Technical Drawing have to be British. This was my own idea in my own law. And I said they got to be British because I know British. If they make up their minds they want to do something, they will commit themselves to forget even their families their wives until the thing is successful. This was true of the British I knew; I don't know of the younger generation of Britons today. But certainly from my generation up I can tell you if they say they can take on a job, they will do it. So I said the Heads of Departments have to be British." (Interview 22/2/1987)

The Vice-Principals and the Assistant Head of Departments will come from Kano, the idea being the indigenes will eventually take over the main responsibilities of the schools and the departments from the expatriate leaders of the Science Schools.

The first teacher recruitment tour was to England. In its 1st July 1977 edition, *The Times Educational Supplement* carried an advertisement (p.64) issued by the Nigerian High Commission in the United Kingdom which invites interested British science and technical teachers to apply for teaching appointments with the Science Board in all science subjects including and Mathematics, Technical Drawing and English Language, and in all posts. According to one of the British teachers (Technical Drawing) recruited at the time (and being British, was made a Head of Department),

> "Twelve British expatriates were recruited, none with less than eight years overseas experience. Six were to go to each (science) school. We were all informed that we were recruited for our known expertise. We were informed at the time of recruitment that the State (Kano) was faced with low levels of expertise in all fields of science and technology. All were told that they were taking part in an experiment that would have far-reaching consequences in Kano State. All were told that it was their expertise that the Board was looking up to. All were told that they were expected to be as innovative as possible."[10]

Here it is significant to note although expertise was a much desired property of the teachers recruited, the issue of the nature of the curriculum they will handle was never communicated to them. Yet this is important, because as explained by Driscoll,

> "It is (in) the recruitment of teachers who have been trained in the techniques of Nuffield Science, team teaching and discovery learning that (one) finds (his) role requirement entirely different to what is expected of him. He would have been told that Nigerian children are eager to learn (very true), but he would not have been told that Muslim children expect the same teaching styles as they found in the Quranic schools. Children see secondary school as an extension of the Quranic school and expect the teacher to think like-wise. It is the greatest source of European teacher frustration and therefore a source of conflict that I am aware of in classroom teaching situations in the Northern States." (Driscoll 1980 p.15)

Thus the expatriates recruited, especially the British, and possibly the Americans - even though many may have had experiences teaching in similar cultural contexts to Kano - came to the Science Schools with a fixed expectation of the sort of curriculum they are expected to teach (e.g. 'Nuffield Science').

But although the expatriate teachers, especially those from U.S. and U.K. were considered the best by the Science Board because of their relatively wider exposure to events and developments in science education, they are also very expensive. And the economic atmosphere that saw the creation of the Science

[10]. Driscoll (1980 p.41 and 33). Terence Driscoll was a British Technical Drawing teacher employed at the Dawakin Kudu Science Secondary School, from 1977-1979. The present work quoted was a term paper he submitted for his M.A. coursework requirements at the EDB, University of Sussex, and given to the researcher. I had few discussions with Driscoll and these yielded further insights into the project at its early stages.

Secondary Schools with attendant overseas tours to recruit highly qualified expatriate staff had, by early 1980s changed into an ugly weather pattern. As a Kano State government report stated,

> "It should be noted that two thirds of the Senior Staff are expatriate recruited from U.K. About N40,000.00 will be required to pay them their 15% contract addition and another N15,000.00 will be needed to pay some of them who will be due for their 15% contract gratuity (during the current financial year). The total cost of passages to Nigeria of the 18 recently recruited expatriate will be about N8,000.00." (Kano State 1979a p.153)

Moreover, the continuously depressing economic situation of Nigeria forced the federal government to introduce stringent measures of foreign exchange control from 1982. Subsequently, this led to a reduction of expatriate home remittance allowed by the government to about 25% and a further restriction of expatriate recruitment facilities by the various state governments in Nigeria. This, inevitably, has to force the Science Board to increase its recruitment drive of local (i.e. Nigerian) teachers, and although it would have preferred indigineous teachers (i.e. from Kano State since they are not employed on contract basis). But graduate teachers from Kano rarely apply to teach science in Kano, not even in the Science Schools, as Table 5.4 shows.

Table 5.4: Summary of Teaching Applications to the Science Schools, 1986

Subject	All	Kano	Others	Grad. Kano	Grad. Others
Biology	86	13	73	3	51
Chemistry	57	8	47	5	20
Physics	34	9	25	1	11
Maths	49	17	31	5	7
English	69	11	54	1	17
Totals	**295**	**58**	**230**	**15**	**106**

(Source: Science Schools Board, 1987)

The scarcity of Kano graduates applying to teach in the Science Schools as reflected in Table 5.4 was attributed to two direct reasons, and were made clear to the Science Board by various teachers during the formers' familiarization tour of the various institutions under the Board between January to March 1985.

First was general welfare. Despite being established since 1977, the Science Board has not yet worked out conditions and schemes of service for its employees - and that included the teachers. As the Report of the Familiarization tour tabled before the Board on 17 April 1985 recorded,

> "Staff employed by the Board on Permanent appointment (from Kano) expressed fear and uncertainty on their future, considering that the Board is yet to have conditions and Schemes of Service from which they can assess their future prospects and benefits on retirement or death."

The second reason was a direct outcome of the Nigerian economic prosperity. In past it become an established service norm for university graduates to expect to have a car when they start their jobs through a car loan facility. And due to the inefficient nature of the transport system any where in Nigeria, the desire for the car becomes necessary for young university graduates both as social symbols and as the only practical means of movement. This has reached a point where the issue of a car loan becomes a determining factor on whether to stay or not in an organization. As the report of the tour of the Board further recorded,

> "The staff also vehemently complained of lack of Car loan facilities in the Board for the past four years and urged the Board to consider as a matter of urgency providing car loan facilities to alleviate the sufferings of staff, especially those stationed outside Kano municipal."

These two issues - conditions of service and car loan facilities - were mainly responsible for lack of teachers in some disciplines, especially those from Kano. As the Principal of a Science School observed,

> "When I came here I don't think we had more than four Kano State teachers. When you recruit, they leave soon after. And the main thing here is car loan. So when he finds anywhere he can get car loan, he just quits and goes. So obviously we are losing most teachers who don't care about other incentives, but the car loan. Give him the car loan and possibly pay his salary after forty days, he won't mind." (CTV 27/2/1986)

And since the conditions of service in the industrial establishments for young university science graduates are far more attractive than what the Science Board could offer, it became a pattern over the years for teachers to use the Science Board as a basis for moving to lucrative careers - a situation not favoured by the Board. As the Minutes of the Meeting of the Board held on 20th November 1985 observed and recommended,

> "The Board is fully aware that in the past, officers have used the Board as stepping stone to bargain for higher salaries with other employers. The Board will therefore consider the following: henceforth all Senior Staff employed by the Board on first appointment be employed on one year Provisional appointment. Salary scale to be offered to such officers should be the same as for officers with similar qualifications and experience joining the civil service. On satisfactory completion of one year provisional appointment, the officers should be converted to permanent and pensionable or contract officers."

But during my field work, this recommendation became a focus of my discussion with many teachers who pointed out although they have been on provisional appointments for over a year, the Board still has not upgraded them. And since they are convinced they can earn better salaries - and some put it, better job satisfaction - in industries, some had already started negotiating for alternative appointments. It would seem that by 1986 the very essence of the Science Secondary Schools Project had undergone some form of transformation, and the zeal with which the projected was initiated, sapped away by evolutionary factors, none of which was anticipated and therefore planned for, by the initiators of the project.

5.3.6 Fundamental characteristics III: The pedagogic context

Getting the science schools properly equipped became the next priority of the Science Board during the intial start of the project. In an internal communication dated 25 March 1977, the Board noted

> "since the appointment of the Science Board, discussions have been going on on the need to equip the Science Secondary Schools with up-to-date instructional materials/equipment whenever they (schools) are officially opened. The educational/pedagogical reason for this is simple. Students to be admitted will, in the main, come to the Science Schools deficient in vital areas, Maths and English. In order to remedy this and also lay solid foundations, conscious efforts must be made to ensure that both the teaching techniques and the learning styles applied are relevant and result-oriented. Once course contents take cognizance of interest/relevance/meaning and use of instructional technology, results are bound to be improved positively and speedily. In this regard, the following suggestions are put forward:

a) that publishers, as many as possible, be requested to supply the Board with catalogues and specimen copies of modern instructional materials for inspection
b) such request should cover the following areas: Physics, Chemistry, Biology, Technical Drawing, Maths and English language.
c) that standard equipment for Physics, Chemistry and Biology labs be obtained from Ministry of Education. (List of technical drawing room equipment should also be obtained)."

Here is is possible to see the Science Board does not seem aware of the current trends in science education reform, otherwise a more structured view of the curriculum materials - rather than the random process adopted - would have emerged. It was aware science needs to be taught in the Science Schools, but not aware of how it should be done. I raised this issue with Ayagi who admitted

> "Many of us in the (Manpower Development Committee) were not science graduates. We were simple teachers of Arts and so on. Our main interest was to provide a situation where you give yourself the chance to select the best students that are endowed in science and develop that so that they could now perform better than they used to. The idea of being dissatisfied with the teaching of science at that time was not in anybody's mind. Not as a concept. We were only dissatisfied with the performance, and therefore indirectly with the teaching of that science to our pupils at that time. Okay may be there were deficiencies in the teaching method. May be. But the only way out is to get excellent teachers, and get excellent equipment. We had no quarrel with the equipment as we didn't even know the equipment. We knew there were equipments and there were syllabuses and so on. But we didn't bother ourselves even to look at them because we were not experts. Our expertise is only in provisions." (Interview 7/1/1987)

This lack of expertise, plus opposition to the project made initial equipping of the schools, and subsequent maintenance quite difficult, although those charged with the project implementation have their own ways of solving some of such problems. As the second Executive Secretary to the Science Board, Mallam D S Ibrahim remembered the situation in 1978,

> "I found myself trying to equip the two Science Schools with virtually nothing. Now what happened was at that time we had problems in getting science equipment. But then we found that there were quite a number, in fact more than we can use, stashed in various Teachers' Colleges as science equipment meant for the UPE teachers colleges which I thought at that time will never be used. So what I did was I went to some of these teachers colleges and cart them out and distributed them to these two science schools! And that nearly cost me my job because I did it in the most, well, I know the Principals and I went and took it from them and I made a list of all I took, and I dumped them to these two science schools. And having done that , I then notified the Ministry of Education, because I knew I told them before I will never get it. I had some queries, but by then it was too late." (Interview 29/9/1986)

Again here personal commitment coupled with fellowship linkages emerge as significant factors in the project, even though there was a financial vote for it. And the problem was not restricted to the initial stages only. During the inaugural Familiarization Tour of the newly appointed Science Boardin March 1985,

> "...complaints were made to the Board in all schools visited on inadequate allocation of funds made to schools for purchase of instructional materials necessary for quality teaching and learning. The allocations made to the schools on teaching equipment were far too inadequate as against actual requirement." (Minutes of the Board, 17 April 1985)

But the reason for this was attributed by the Science Board to insufficient funding. And although the fellowship network that ensured the survival of the Science Schools project in its infancy have ceased to be very important now the infant has become a child, the problems of lack of support from other arms of the civil service were still persistent. The Minutes of the Board further explained,

> "The Board is requested to note that for two years running (1983 and 1984), the Ministry of Finance and Economic Planning has been under-paying the Board its approved budgetary subventions by amounts ranging from over three hundred thousand naira (N300,000) in 1983 to over four hundred and fifty thousand naira (N450,000) in 1984. In the first three months of 1985, the Ministry underpaid the Board four hundred and fifty six thousand naira (N456,000) through unexplained cuts from monthly subventions due to the Board. Since payment of salaries (and related allowances), students feeding and passages are basic, it is evident that these cuts adversely affect funds earmarked for purchase of teaching materials."

But the issue of the science teaching emphasis in the schools still remained not addressed by the Science Board. However, two attempts were made to to make the Science Board provide framework around which a recognizable policy of science education can be used as a basis for teaching and learning in the Schools.

The first attempt came from the Comparative Education Study and Adaptation Centre (CESAC) of the University of Lagos which has developed a new science programme called the Nigerian Secondary Schools Science Project (this was adopted in all Nigerian schools in 1985 as a new science curriculum, and is analysed in Chapter 6 of this thesis). This was in 1979 and was the result of visits by the CESAC team to Kano and especially to the Science Secondary School Dawakin Tofa. From the visits and discussions with some of the officials of the Science Board, the team leader, Dr U M O Ivowi later sent a communication on 25th May 1979 to the Executive Secretary in which he said the team was

> "convinced of the existence of adequate facilities and resources for an effective execution of our science project. With good laboratories and equipment, your experienced staff should have no difficulty in teaching science through the discovery approach which our project advocates...We assume that one of the major aims of establishing the special schools for science education is to accelerate the rate of production of scientifically competent boys and girls for science and technology activities in our higher institutions and in the economy. This is the underlying objective of our science project in our school system. We present science in a practical way; we encourage pupils to 'do' science and not 'read' science; we work towards the development of scientific skills and attitudes in pupils. If we have correctly read your motive of establishing science secondary schools, it appears that we have a basis for a cooperative effort at achieving our science and technology goals."

There does not seem to be any acknowledgement to CESAC by the Science Board about these proposals. This is because on 20th August 1979, CESAC sent a reminder to the Science Board adding,

> "We are particularly interested in playing a part in your science endeavours at the secondary school level in the State. You may wish to suggest a meeting in Kano with your officials to discuss our proposals. In that care, we shall be very pleased to be in Kano at your own convenience"

There was no further communication after this. The interest of the CESAC in the Science Schools of Kano is justified by the innovatory nature of the schools, as well the science education activities of CESAC itself. Both were new ventures in science education. And with the full adoption of the CESAC developed science curriculum in all Nigerian schools in 1985, the Science Schools have the unique property of combining two science curriculum reform strategies. But because the CESAC and the initiators of the Science Schools Project were motivated by different reasons, as well as different priorities for engaging in the science education reform, break down in communication between the two was a natural consequence.

The second attempt to get a clearer idea of the level of expectations of the science teaching and learning dynamics from the Science Board was from an internal source. On 24th June 1981, a group of teachers (most of them expatriates) from the Dawakin Kudu Science School wrote a communique to the Science Board expressing their concern about the curriculum of the Science Schools by stating,

> "In the past four years of existence of the science schools, it is evident that there has been a clear lack of academic and professional leadership conducive to better teaching and learning in these schools. The major reason for this is the fact that the science schools are dependent on Kano Educational Resource Centre for these services. The decisions made by the KERC on most academic and professional matters are often against the best interest of these schools. The science schools depend on the KERC for professional advice and help, Common Mock Examinations, and organization of various academic competitions"

The teachers' communique requested the Board to set up a professional service unit within the Science Secondary Schools Management Board. In the analysis of their reasons for this (and thus independence from the KERC), they argued

> "Since the inception of the Science Schools in 1977, the professional association of the KERC with these schools has been limited to one inspection for the purpose of recognizing the schools for the West African School Certificate Examinations. In addition to this, the inspectors in KERC have provided the schools with schemes of work in various subjects. In most subject areas, these schemes are totally irrelevant to the needs of the schools, and they seem to defeat the whole purpose for which the science schools are established. These schemes are just a collection of topics without any central theme, nor are they designed to cater for the particular needs of the science schools. The very fact that the students in these schools are selected to do science courses in an atmosphere different from that of the conventional secondary schools, calls for the need for special teaching programmes and schemes in these schools. The KERC has made no effort to come forward with any constructive programme to be implemented in the science schools."

It is thus interesting that in all the preparations for the establishment of the Science Schools there were no professional services, until much later when as a result of lack of Membership to the Board, the Science Board set up various committees to handle its administration, and which included the Academic Committee.

But the Academic Committee does not provide for the services required by the teachers. If anything, the Academic Committee was mainly concerned with admission of the students to the Science Schools. It offers no professional guidance both on the teaching processes or on selection of books and equipment to the Science Schools, even though its functions were formally listed to include such services. This was because the Science Board itself was not clear on how to go about this. I asked a high official of the Science Board the criteria, for instance, used in selecting books for the Science Schools. They have none, because

> "The KERC studies all the textbooks currently in the market, and then they recommend suitable textbooks for each subject. Based on this recommendation, then we buy whatever textbooks are in the market for particular subjects." (Interview 23/9/1986)

This was almost ten years after the establishment of the Science Schools. The selection of equipment was carried out by a similar method. As the interview further recorded,

> "Selecting laboratory materials is a simple thing, because all you need to do is look through the syllabuses sent in by WAEC, CESAC or whoever was developing the syllabus. From there you will see the kind of things you need." (Interview 23/9/1986)

Therefore although the Science Schools project was conceived as a radical strategy aimed at eventual social transformation through science education, its political and economic priorities overshadowed its academic priorities.

5.4 Section IV: Analysis And Conclusions

This chapter traces the emergence of the Science Schools project from 1975 to 1985, paying particular attention to its most fundamental characteristics: genesis, the students, the teachers and the pedagogic context.

Although not all aspects of the project were discussed in the account here (the rest being taken care of in the subsequent chapters), the account provides a basic framework for analysing the origins of the project. In the analysis, I will draw from two theoretical bases as identified in Chapter 2. The first deals with the general pattern of changes in education, and the strategies of implementing the changes. The second base discusses the emergence of the project in terms of its structural components.

The theoretical implications of the project are wide, but clear. The emergence of power, authority and fellowship network connections in getting the project started clearly defies any theoretical assumption which suggests implementation of innovations, or indeed even their emergence, is the outcome of mutually agreed set of priorities. In this, the Authority Innovative Decision model proposed by Rogers and Shoemaker (1971) seems be confirmed, although the authority figures did not follow all the patterns envisaged by Rogers and Shoemaker. For instance, although there was an awareness of the need for the Science Schools, there was a lot of persuasion and arm twisting regarding the intended change (Science Schools), but there was no dialogue as to whether to adopt or reject. Adoption was forced because the policy initiators had enough power or what I call Fellowship Network Interactions to get it through. The Fellowship Network Interactions strategy therefore emerged as the main motor of certain types of educational change activity in Nigeria.

This development did not confirm Havelock and Huberman's (1978) expression of power in educational changes, especially where they argued,

> "It is certainly hard to imagine how a complex project with ambitious goals could ever succeed without a set of rules and procedures which everyone was obliged to follow, and this inevitably means surrendering some amount of autonomy. No one would seriously argue this point.

> The real question is how far can one rely on such mechanisms as the primary or sole means of introducing a change." (Havelock and Huberman 1978 p.256)

But the development of the Science Schools clearly demonstrates that power can be used as the sole mechanism of introducing change. However, even within the framework of this counter-argument, power alone, as the account of the Science Schools show cannot get educational reforms introduced and implemented. The Ministry of Education Kano was presented with a proposal to set up the project. It rejected it. No amount of power coercion could force it to agree to the project. That the project became possible was coincidental. And even then, the inadequacy of power alone manifested itself in that although the project has become a government concern, opposition to it could have prevented it from operating at full functional capacity. It was the personal commitment, friendship and understanding among those charged with implementing the project at its infancy (especially 1977 to 1982) as well as their combined influence in the Kano State political hierarchy that made the infant a robust toddler.

This dimension (fellowship network interaction) does not seem reflected in any theoretical model which describes how educational changes come into being, although elements of it were acknowledged by Rogers and Shoemaker (1971). What makes it unique is its combination of elements of Diffusion strategies (Havelock and Huberman 1978 p. 259) and Power Coercive strategies in describing the origin of educational innovations. But this dimension of educational change is not complete because it describes the change process only in terms of the policy initiators, and excludes other components of the process.

The second theoretical base is the IAC project pattern synthesized by Havelock and Huberman (1978) which describes educational innovations in terms of their structural components. In using the IAC as an analytical tool, I encountered some problems not taken into account by the model. For instance, it was not clear whether such project patterns adopted by any change strategy will remain fixed for the rest of the duration of the project. This is because, as demonstrated by the genesis of the Science Secondary Schools project in Kano, due to changes in political sentiments and unstable nature of economy (both not accounted for by the project) shades of patterns fade out.

To begin with, the first pattern discernible, using the IAC framework, is I+ A+ C-, where good infrastructures (I+) - both the Science Schools newly acquired and the Board newly created to manage them - are coupled with enthusiastic authority (A+) but with general low consensus (C-) considering the strength of the opposition to the Science Schools both within the Kano State Executive Council and as provided by the Principals of the feeder schools.

But the authority itself did not remain A+ because a change in government saw the ushering in of an I+ A- and C+ configuration, in which other socio-politically powerful forces within the Kano State Civil Service attempted to block the project. The Commissioner for Education in 1980, for instance, did not approve of the schools (creating an A-). And by then the effect of the A+ in the first configuration has generated some measure of consensus in this second configuration (C+). This is surprising since with an unenthusiastic authority (A-

), consensus, which has never been positive to begin with, should also be negative.

But the second configuration (I+ A- C+) does not enable us to determine the nature of the consensus. For instance, from the account of the genesis given in this chapter, it emerged although some members of the Kano State Executive Council still opposed the project, the Principals of the feeder schools seemed to have accepted it in the sense of allowing their best students to be taken away to provide the first set of students for the Science Schools. This is the conclusion given by the I+ A- C+ configuration. But as the events showed, this was a forced consensus on the part of the Principals. Thus the model does not enable us to distinguish between a consensus arising from conviction orother, hidden, political forces. This is quite important, because as Havelock and Huberman (1978) suggested,

> "We would predict that C+ is a critical component at the local level in order both to initiate and to implement an innovation. Also, when C+ is obtained at this level, I+ and A+ are more likely to accompany it." (p.84)

But this is not so according to the pattern of development of the Science Secondary Schools project. Consensus can be forced in one authoritative form - getting the students to the school by whatever means. But getting a measure of co-operation from those responsible for implementing the objectives of the project is another issue. And in the case of the Science Schools Project, C+ (obtained by whatever means) was not accompanied by I+ and A+ at the same time. Indeed, I+ seemed to be independent of C+ but quite reliant on A+.

In any event, this configuration did not last long, as a third one emerged which showed I+ A+ C- reverting back to the first type, and some Principals refused to allow their students to be taken away from their schools. Indeed, by this stage, it might even be possible to discern a configuration of I+ A- C- because the opposition to the project (A- and C-) resurfaced itself again over the decade in various forms. And throughout all these changes in the configurations of the project pattern, I+ has remained more or less positive; i.e. the infrastructure, as can be deduced at this stage, has remained what it should be. To determine the extent to which this is so, it is necessary to analyse the Science Schools themselves, to see if another project pattern, different from what has emerged here could be obtained. This will done in Chapter 7. As a prelude, I will now analyse the science curriculum used in the Science Schools.

Chapter 6

Analysis of the Nigerian Science Curriculum

6.0 Introduction

This chapter analyses the science curriculum used in the senior secondary schools in Nigeria and in the Science Schools in Kano State. The analysis focuses on the curriculum as the main mechanism of translating the objectives of the Science Schools project into practice.

The analysis is guided by the following research question: What is the emphasis of the science curriculum used in the senior secondary schools? What are the most significant features of the science curriculum? And since the analysis also looks at the curriculum in the context of Science Schools, specifically it wishes to find out: how do the objectives of the science curriculum relate to the objectives of the Science Schools? The sources of the data therefore are the science curriculum and the way it is interpreted in the classrooms, although this latter will be explored more extensively in Chapter 7.

The analysis is carried out in five sections which are based on the framework of the Analytical Scheme used for this research (see Appendix 1 for its development). Section I traces the background history of the new science curriculum project. Section II analyses the rationale as well as the curriculum strategies contained in the new science curriculum, while Section III looks at the antecedent conditions implied by the science curriculum and the organizational context within it is designed to operate. Section IV is an intrinsic analysis of the curriculum, while Section V contains concludes and outlines the main findings of the analysis.

6.1 Section I: Background History the New Nigerian Science Curriculum

6.1.1 Genesis of the Curriculum

Like most developing countries, Nigeria sees rapid social and economic development through a systematic process of scientific manpower training and education, a view closely connected with the effects of the waves of science education reform movements in other countries of the early 1960s, especially in developing countries.

Dissatisfaction with the emphases of the then existing West African Examinations Council, WAEC, science curriculum in the 1960s set in rapidly in Nigeria. The developers of the new Nigerian science curriculum were not convinced the WAEC produced science curriculum reflected the developmental aspiration of the country. There were also the feelings the existing science curriculum did not provide adequate scientific learning experiences for students for them to become a large stock of skilled manpower for science and technological progress. As an analysis of the former WAEC science curriculum claimed,

> “the contents were a combination of disjointed topics in each of the science subjects with no unifying concepts to make both teaching and learning easily attainable. There was no attempt to show the relationship

> of some topics to the others; no effort was made either to relate the learning experiences of the students to their immediate environment and life encounters. No proper scientific skills and attitudes were acquired by the students." (Ivowi 1982a p.5)

This dissatisfaction provided a basis for proposing a new science curriculum in Nigeria. This was suggested by the Comparative Education Study and Adaptation Centre (CESAC) of the University of Lagos in a co-operative venture with the Science Teachers' Association of Nigeria (STAN).

The proposal led to the establishment of the Nigerian Secondary Schools Science Project (NSSSP) which eventually became the new science curriculum in 1985. The NSSSP had its beginning at the Curriculum Development Conference in the University of Ibadan in August 1969 and which

> "formed the basis of the only known positive curricula plans aimed at providing a better, more purposeful and utilitarian science education for the country. This has led to the production of the STAN Integrated Science Project (NISP) and the Aiyetoro Basic Science programme (later revised as CESAC Basic Science for Nigerian Secondary Schools - BNSS), for forms one and two of our secondary schools; and the CESAC Nigerian Secondary Schools Science Project (NSSSP) in Biology, Chemistry and Physics for forms three to five. These innovations have so far emphasized widely held views about how science should function in our secondary school curriculum." (Ivowi 1982a p.3)

Although the production of these new science curricula was influenced by American science curriculum development activities, the Nigerian Secondary Schools Science Project was careful to avoid stating this influence. But its Biology teachers guide, for example, constantly referred to the American Biological Sciences Curriculum Study project materials for further guidance.

Like other science curricula influenced by the broad themes of the science curriculum reform movements, (e.g. to emphasize the learning of science by active pupil participation, to ensure a high supply of scientifically aware and trained manpower etc), the NSSSP advocates learning science through the "discovery" method as being the best possible way science can be taught, especially to secondary school students (from Grade 10-12). The most significant features of the NSSSP, as stated by its developers reflect this view:

> "In the NSSSP, the conceptual approach, which makes use of a theme that runs through the entire course, has been used in designing the project. The discovery method of teaching, which follow the Gestalt Psychology of learning, is suggested for presenting the materials. In all cases, relevance of the subject to the society in terms of application is emphasized. Instead of the usual lecture method followed by separate practicals, a new teaching approach, the discovery method, is suggested. To this end, active students participation through experimentation and discussion, with the teacher playing the role of a leader and not a preacher, is advocated." (Ivowi, 1982a p.9 and 10)

The NSSSP was presented as a whole package accompanied by teachers guides and pupil's textbooks. The syllabuses for the project's science subjects were given a separate section in the WAEC syllabus and called “Alternatives” (see WAEC 1985). They were in Biology, Chemistry, and Physics. All the materials were produced by CESAC and published in their trial versions in 1970-72, with the final revised versions being published in 1981 and marketed by Heinmann Educational (Nigeria) Limited. The first set of candidates who were examined after following the NSSSP science materials took the ordinary level examinations in the new science courses in 1974. The results,

> “despite the general complaint that the examination papers in Physics, and Biology were largely unrelated to the syllabuses, were encouraging. Since 1975, more secondary schools have become involved with the project. At the moment, there are sixty pilot and thirty associate pilot schools for the project.” (Ivowi 1982a p 10)

Although it was never made clear the extent to which Nigerian science teachers were involved in the development of the NSSSP materials, Ivowi states that Nigerian science teachers

> “agree that the courses, if properly followed, are capable of producing students of superior understanding of science. People are generally convinced that the activity-oriented nature of the courses is a proper step towards the development of scientific skills and attitudes so vital to the future technological growth of this country.” (Ivowi 1982a p. 11)

These convictions however apply only to the few teachers of the schools that decided to use the NSSSP materials, and who were aware of the NSSSP and attended a training course at the University of Lagos before they begin teaching the course. It does not reflect a general view of Nigerian teachers concerning the viability of the NSSSP materials. But in spite of these encouraging signs about the acceptability of the NSSSP materials among some teachers in the country,

> “Up till now, no systematic measurement of the educational outcome of this project has been made. Although there has not been a follow-up study of the performance of students who took the NSSSP courses at schools in their after-school careers, yet efforts are being made by the (CESAC) to do exactly this. All the same, reports from some of our Universities tend to indicate a commendable understanding ofand performance in the science courses by these students.” (Ivowi 1982a p. 11).

This optimistic conclusion must be taken with caution. This is because it assumes any post-project performance of students who followed the NSSSP (especially if outstanding) reflects the effects of the project. This contention is difficult to quantify, especially if there is a wide time interval between project initiation and impact measurement. However, despite the advantages of the new project materials,

> “...a slight complaint about the NSSS Project texts exists. This concerns the provision of inadequate concession to the localities of this vast country. Every effort was made to take into consideration the vast differences in vegetation, climate and culture of our people. Although many examples given in the texts are drawn from the Nigerian scene,

> the vastness of the country makes this not completely representative enough of the events in all our localities. The textual nature of the project also limits the ease with which local adaptation could be made of the project by the teachers." (Ivowi, 1982a p.11)

The description of the NSSSP was given full attention here because it was the direct antecedent to the new Nigerian science curriculum, and will therefore be the main focus of analysis subsequently.

6.1.2 The New National Policy on Education

In 1982, the Nigerian federal government decided to introduce a new policy on secondary education which divides secondary schools into a junior and a senior section each of three years duration.

In pursuance of this policy in the implementation of the Senior Secondary stage of the National Policy on Education, which was seen as providing more opportunities for social and economic development through comprehensive system of schooling, CESAC was requested by the Federal government to adapt the NSSSP materials for use in all the Senior Secondary Schools in Nigeria in September 1985. Adaptation was made easier because the NSSSP materials were already being used in some secondary schools in Nigeria. In Kano, the trial schools for the NSSSP were Government Secondary School Hadejia and Rumfa College.

Moreover, the NSSSP materials were initially aimed at a level of schooling which is equivalent to the present senior secondary schools (Grade 10-12). The essence of the NSSSP materials, including the rationale, overall aims and objectives for each of the three science subjects, were retained in what is now a new federal science curriculum. In addition, detailed proposals for teaching techniques were suggested. In my subsequent analysis of the new Nigerian science curriculum, the basic rationale of the NSSSP will be referred to in cases where its rationale needs to be analysed and which is not written in the new science curriculum.

The newly adapted science curriculum was presented to a National Critique Workshop organized by the then Federal Ministry of Education, Science and Technology in December 1984. The result of the critique was presented yet again for another critique at the Joint Consultative Conference (JCC) Committee Meeting held in April 1985. The final version was presented and approved at the meeting of the National Council on Education in July 1985. In September 1985, the curriculum was introduced into the newly established senior secondary schools. The curriculum was published by the National Educational Research Council (NERC 1985).

6.1.3 Description of the Curriculum

Although the new curriculum is described as such in the National Policy on Education (its full title is: National Curriculum for Senior Secondary Schools) and issued by subject disciplines, its most distinguishing feature is it is a syllabus guideline. Thus in all references to curriculum, it must be kept in mind I am referring to these syllabus guidelines only, since no other materials were produced to accompany the new curriculum. It should also be borne in mind that since the developers of the curriculum perceived it as course (they keep referring to it as such), often the term "course" is used to mean the syllabus guidelines, especially when used by the curriculum developers.

Each syllabus of the new science curriculum is about 55-60 pages (except the Chemistry syllabus which was 28 pages) and the first three describe, quite briefly, the origin of the curriculum and the various administrative stages it passed through up to July 1985 before it was accepted for implementation in the senior secondary schools throughout Nigeria. This is followed by a description of the overall general objectives of that particular subject, as well as recommended teaching strategies for all the science subjects.

The table of contents then followed, with the list of topics to be taught at each level beginning with SS1 (Grade 10) through to SS3 (Grade 12) structured around a theme. Each theme is made up of various topics grouped under four headings: performance objectives - which give achievement objectives about learning that particular topic, content, activity, and additional notes for the teacher.

6.1.4 The Text materials for the new curriculum

Since CESAC and STAN worked together in the production of the new science curriculum, the latter produced a series of textbooks specifically meant to cover the topic guidelines of the new science curriculum. These books were designated STAN Chemistry, STAN Biology, and STAN Physics. Unlike the original NSSSP materials, there were no teacher's guides to accompany these books (at the time of the analysis - three years after the curriculum was introduced in the schools). The STAN Biology, which was the first of the three to be published, was made commercially available in 1982 and was marketed by Addison-Wesley. The STAN Chemistry was made available only in September 1987, while no specific date was fixed for the availability of the STAN Physics book.

These were the only books produced specifically in relation to the new science curriculum. Other books previously used for the old science syllabuses, were suddenly rewritten to reflect what their authors believed was a more pragmatic interpretation of the science curriculum, and launched just in time for the new policy. These "New Editions" became the only books available in Nigeria in the absence of any other books to accompany the new science curriculum. See Appendix 1 for further discussion on this.

6.1.5 Structure of the New Science Curriculum

An analysis of the general characteristics of the new science curriculum as contained in the syllabus guidelines reveals its mechanism. The first significant point was in detailing its structure where its developers explained,

> "In planning for this course, the **Spiral** (or ***Concentric***) approach to sequencing a science course was adopted. In the approach, the concepts to be taught are arranged in such a way that they run throughout the three-year course, the concepts being discussed in greater depths as the course matures over the years." (NERC 1985a p.ii)

But the most ambitious aspect of the new science curriculum lies in its suggested teaching techniques. As it stated,

> "In accordance with the stated objectives, the contents and context of the syllabus places emphasis on field studies, guided-discovery, laboratory technique and skills coupled with conceptual thinking (NERC 1985a p.ii). So teachers are strongly encouraged to employ the student-activity based on an inquiry mode of teaching. Ample opportunity for laboratory activities and discussion has therefore been provided for every unit of the course. To stimulate creativity and develop skills in students, opportunity is also provided for the construction of workable devices in appropriate units of content (NERC 1985c p.ii)

This reflects the general suggested teaching strategies of the science curriculum reform movements in other countries (see Chapter 2).

6.2 Section II: Rationale And Curriculum Strategies

6.2.1 General Rationale

The general rationale for a new science curriculum in Nigeria arises from the main consideration that science, as a powerful tool of social advancement has not made its impact on the schooling process in the country. As Ivowi (1982a) observes,

> "so far the country has not made any impact on technology and yet our survival as an independent sovereign nation depends very much largely on our ability to be sufficiently self-reliant on our own production of goods and services." (Ivowi 1982a p.5)

This theme of seeing science education as the primary step towards social and economic self-reliance has become recurrent in the rationale given for a new curriculum reform in developing countries (e.g. as in Alabi 1980, Knamiller 1984)

In addition, there was a need to devise what are considered more pragmatic and result oriented strategies around which these messages (science for development and self-reliance) could be effectively presented to the Nigerian child. Again, it was realized the science education programme offered to the Nigerian children before the advent of the new curriculum may not enable them to acquire the skills considered necessary for scientific self-reliance. As Ivowi further analyses

> "In upper classes of the schools, the topics taught were in obedience to the stipulation of the examination board. The science curriculum at this level did not appear to meet the needs of the society which the schools served. Except for those who went further in the sciences on leaving school, the learning experiences acquired served little or no purpose in the students' interaction in the society. No proper scientific skills and attitudes were acquired by the students." (Ivowi 1982a p.5)

The solution to these problems was seen to lie in developing a new, more relevant science course for the Nigerian child, and since this echoes the fundamental characteristics of the new National Policy on Education, the general aims of each of the individual syllabus guidelines reflect this.

6.2.2 Aims and Objectives

The general aims of each of the three science subjects considered for this study (Biology, Chemistry and Physics) are explicitly stated by their developers to reflect both the sociological as well as academic aspirations of each of the three science curricula. The Biology syllabus lists its objectives as enabling pupils to acquire

1) Adequate laboratory and field skills in Biology
2) Meaningful and relevant knowledge in Biology
3) Ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture
4) Reasonable and functional scientific attitudes

In addition, it was stated the syllabus is intended to provide “a modern Biology course as well as meet the needs of the society through relevance and functionality in its contents, method, processes and application” (NERC 1985a p.i)

Similar sets of objectives were given also for Chemistry and Physics and reflect variations in the nature of the expectations for these subject disciplines. The objectives of the Chemistry Curriculum are to

1) Facilitate a transition in the use of scientific concepts and techniques acquired in Integrated Science with Chemistry
2) Provide the students with basic knowledge in chemical concepts and principles through efficient selection of content and sequencing
3) Show Chemistry in its inter-relationships with other subjects
4) Show Chemistry and its link with industry, everyday life, benefits and hazards
5) Provide a course which is complete for pupils proceeding to higher education while it is at the same time a reasonably adequate foundation for a post-secondary Chemistry course.” (NERC 1985b p. ii)

Finally, the Physics curriculum stated

“The following objectives are to be satisfied by the senior secondary school physics curriculum:

1) To provide basic literacy in Physics for functional living in the society
2) To acquire basic concepts and principles of physics as a preparation for further studies
3) To acquire essential scientific skills and attitudes as a preparation for the technological application of physics
4) To stimulate and enhance creativity” (NERC 1985c p.ii)

Although all the three science subjects were developed at the same period, the statements of aims and objectives as detailed above do not seem to reflect a common pattern.

6.2.3 Teaching and Learning Mode

The new science curriculum in Nigeria explicitly advocates the "guided discovery" method of teaching science. The teaching strategy recommended is based on student-activity. As explained in the new science curriculum,

> "In accordance with the stated objectives, the contents and contexts of the syllabus place emphasis on field studies, guided-discovery, laboratory technique and skills coupled with conceptual thinking. So teachers are strongly encouraged to employ the student-activity based on an inquiry mode of teaching." (NERC 1985c p.ii)

6.2.4 Curricular Content

Each of the three science subjects in the new curriculum it is stated, is based on themes. In this approach, the concepts to be taught are arranged to run throughout the three-year course of the curriculum, the concepts being discussed in greater depth as the curriculum matures over the three years. This follows a concentric approach of structuring the materials.

In Biology, some of the themes occurring throughout are form and function; ecological relationships; conservation of matter/energy, and metabolism. The themes for the Chemistry curriculum include energy, periodicity and structure. While in Physics some of the themes are motion and energy. Appendix 1 lists all the themes for Biology and Physics as given in the guidelines. These were the ones clearly outlined in the syllabuses.

6.2.5 Internal and External Assessment

The internal assessment in the new National Policy on Education is based on continuous assessment of the students throughout the three year senior secondary school, as well as a final examination to be conducted by the WAEC (the West African Examinations Council). Continuous assessment, a new concept to teaching in Kano, has faced problems right from the Junior School phase. As a Commissioner reported in 25th November 1986,

> "Full implementation of Continuous Assessment is hampered, moreover, by inadequate funds." (Kano State 1986)

It was not exactly clear how the external assessment will be carried out in the new educational policy.[11]

However, it should not be expected this will exclude WAEC, even though a major rationale of developing the new science curriculum was an attempt to avoid the rigid structure imposed by WAEC as an examination system. Because as stated in the National Policy on Education,

> "Nigeria will, for the present, continue to use the West African Examination Council as its national examinations body, since this does

[11]. However, a report which did not make the issue any clearer in the 1 February 1988 issue of *West Africa* magazine (No 3675) reads: "The May/June WASC examination will not be held this year, but any State of the Federation wishing to conduct it for its indigenes is free to do so...The existing system will be abolished in 1991 when it is expected all the 21 States will have fully implemented the 3/3 segment of the 6-3-3-4 educational method." And any State conducting the examination will have to pay WAEC for the permission to do so.

> not prejudice national interests, and in fact has advantages." (Nigeria 1981, p.19)

But it is difficult to see what these are for the new science curriculum. On the whole, the most curious aspect of the new science curriculum is its lack of an assessment strategy which will enable its developers to determine how effectively it is being used. Continuous assessment as embedded in the new policy serves only to provide a general picture of the educational spectrum in the classroom. It does not enable a measurement of achievement of the performance objectives, in which the new science curriculum places so much emphasis.

6.3 Section III: Antecedent Conditions

6.3.1 Pupils ability range

The new science curriculum in Nigeria is meant for senior secondary school students (pupils aged 14-17, although ages up to 20 are common). This level was meant for highly academically motivated pupils. As stated in the National Policy on Education,

> "Students who leave school at the junior high school stage may then go on to an apprenticeship system or some other scheme for out-of-school vocational training. The senior secondary school will be for those able and willing to have a complete six year secondary education. It will be comprehensive but will have a core curriculum designed to broaden pupils' knowledge and outlook." (Nigeria 1981 p. 17)

All senior secondary schools throughout the country are expected to adopt it. And as the curriculum states,

> "The scope and depth of the contents have been increased slightly beyond the present General Certificate of Education (GCE) ordinary level standard. This is in conformity with the Joint Consultative Committee decision on the level of the senior secondary school programme." (NERC 1985c p.ii)

This suggests a high expectation of achievement from the students during the learning process. However, no explicit rationale was given about the basis for this move. And it is not without anticipated problems. As the Principal of a Science School noted,

> "Since the first copies of the new syllabus were received, we were able to judge that the demand is higher on us, and this is obviously because of the incorporation of some elements of advanced level GCE topics into the ordinary level GCE. With this, there will be a lot of demands. First of all in textbooks. Most of the textbooks we are using are based on the ordinary level GCE syllabus so now they will be inadequate. Either the books need to be revised, or you buy some other set of books for the advanced level GCE at least to provide for those topics that are not covered in the ordinary level books." (Interview 8/10/1986)

Similar comments by other Principals reflect the level of uncertainty the new policy creates in the schools. The new science curriculum therefore sets precedents in its incorporation of what it considers advanced features (as outlined in the Physics curriculum; see NERC 1985c p.ii)

6.3.2 Previous Knowledge and Experience

A very explicit assumption of the new curriculum was the expectation that the students have successfully covered the Junior Secondary School Integrated Science programme. It therefore expects the senior secondary school teacher to build up on this. As stated in one of the syllabuses,

> "...the intent of this syllabus is to provide a logical and psychological follow up for the Junior Secondary School Core Curriculum for Integrated Science. In structuring this syllabus therefore, the content of the JSS curriculum was assumed." (NERC 1985a p.ii)

This suggests an expectation of the teachers' awareness of the details of the performance objectives in the Junior Secondary School Integrated Science course. But not all teachers share the same confidence in the adequacy of the teaching of Junior Secondary Schools Integrated Science. As a teacher explained,

> "The Junior Integrated Science is good, but I don't think it is being covered very well. It is practically impossible because a Biology teacher is given the task of teaching it and that contains elements of Chemistry and Physics. He will only emphasize the part of Biology leaving the other sections. This gives problem to teachers when the students come to Senior Schools." (Interview 15/1/1987)

This view, coming from a teacher in a conventional school reflects a general feeling among teachers of the way the Integrated Science was taught in the Junior Secondary School. A similar observation from a teacher in a Science School consolidates the various views given:

> "I don't consider their coverage of Integrated Science adequate at all. It is never adequate. This is because those asked to teach Integrated Science in Junior Schools are inclined towards Biology. And any Integrated Science teacher inclined towards Biology will take the students through the Biology part of it only. He won't care to touch the Physics or Chemistry aspects, or even if he cares, he will be brief. Some SS1 students will even tell you they have never heard of Physics!" (Interview 25/2/1987)

Thus for the Senior School teachers to build up on the Junior Integrated Science, it would seem well qualified integrated science teachers would have been required to teach the course. This, no doubt, reveals another dimension of the nature of the expectations of the new science curriculum.

6.3.3 Organization of Teaching Groups

No guidelines were given as to how the arrangements about the teaching of the various science subjects in the new science curriculum are to be done, even though the new science curriculum requires a teacher with high degree of professional awareness of its ideals and realities. The writers did not provide a prescription about the balance between classroom periods and laboratory practicals; and this, no doubt, arises because of the activity orientation of the curriculum.

The new science curriculum certainly requires structural changes in the time-sharing process of the school if it is to be taught in the way it was envisaged by its developers. As urged in the introduction to the new science curriculum,

> "Teachers are strongly encouraged to employ the student-activity based on an inquiry mode of teaching. Ample opportunity for laboratory activities and discussion has therefore been provided for every unit of the course." (NERC 1985c p.ii)

But teaching science in this mode is not without its problems. This is because although science lessons last for 80 minutes (i.e. each lesson is a double period), quite a lot of the time is taken up with giving notes to students - a very compulsory feature of the educational process in Kano. As a teacher explains,

> "I am not supposed to give them notes on the blackboard. I am supposed to describe things for them only. But because I have to give notes, I spend a period doing that. It takes a lot of time, and it is supposed to be done by the students on their own at home. But the problem is there are no books. So as a teacher you have to give them notes. They don't want to buy the books." (Interview 16/2/1987)

Thus the notes are vital to students because the books to which they can refer to are not available. This therefore makes it necessary for a lot of time to be devoted to either explanations or writing on the Board for the students to copy - leaving little time for the mode of teaching advocated by the new science curriculum.

6.3.4 Teacher Capabilities and Requirements

The new science curriculum requires a teacher who is aware of the nature of its recommendations for classroom teaching of science disciplines. In Nigerian educational setting, this degree of awareness is most commonly associated with professional training. For instance, although discovery learning was advocated in the science curriculum it was not recognized by its developers that this may be unattractive to teachers with limited or no experience. And guidelines were not given in the curriculum to those teachers who may wish to follow its prescription but were hampered by unfamiliarity with its suggestions.

However, a lot of workshops and seminars were held just before the launching of the senior aspect of the secondary curriculum throughout Nigeria in 1985. Yet these were aimed at making teachers and Nigerian public aware of the general features of the curriculum, rather than its detailed form.

What makes the new science curriculum unique is that it is more than a generalizable policy statement. It came complete with its expectations and suggested methods of achieving these objectives in some areas (see Section IV below). It is therefore reasonable to expect some guidelines on how to accomplish this for teachers not familiar with the strategies it advocates to enable them to achieve its objectives.

6.3.5 Financial and Resource Implications

While the precise long term financial implications of the new science curriculum on an already deteriorating economy are quite hard to figure out, what is more clear is resource requirements to implement the strategies of teaching science as advocated by the curriculum are going to be quite high.

For instance there would be a need for constant supply of laboratory equipment and materials for all the three major science disciplines. Its resource demands also assumes well maintained laboratories with a full complement of well trained personnel.

Thus the mode of teaching science as advocated by the new curriculum presumes an environment good enough to enable students to learn science this way. This, however, may prove to be too much to expect from all schools in the country. As a teacher explained,

> "The new syllabus requires improvization and constant supply of materials. It requires you to use more materials. These things are always not available. So sometimes I just manage with what I have. (Also) It is not in every topic that we do experiments or activity, because most of the time the apparatus are not there. So it is not possible to do activity in every lesson. But sometimes the activity is very simple. You just take something from the lab and show to the students. This can last for only five minutes." (Interview 7/11/1986)

This provides a small insight into the nature of the problems the interpretation of the curriculum in the classrooms will face. The significance of the problem as it affects the whole spectra of educational provisions in Kano (as an example) is indicated by a Commissioner of Education during a meeting of the implementation committee of the policy in Kano on 25th November 1986 where he reported,

> "The implementation of the policy since 1982 has been hedged about with numerous constraints. The first arises because of the emphasis laid by the Junior Secondary curriculum on the need to expose students to pre-vocational subjects so that they may acquire real skills for life long utilization, and may be provided with employment opportunities if they are unable and/or unwilling to proceed further with academic studies. It is regrettable that so far this objective has not been properly realised. This is a result of
>
> 1) The non-availability of pre-vocational tools in many of the subjects concerned
> 2) The lack of teachers with the relevant academic qualifications or the relevant vocational orientation
> 3) The inadequacy of the infrastructural facilities such as classrooms, workshops, laboratories, and instructional materials." (Kano State 1986)

Thus by 1986 efforts were still being made to implement a 1982 educational development, i.e. the Junior stage of the new secondary education policy - a situation which will seriously affect the implementation of the senior stage of the national educational policy. The inability to fully implement these educational programmes was often attributed to the deterioration of the Nigerian economy which started almost at the same time after the machinery for the implementation of the new policy (1982) has been set in motion, and no review of the policy was undertaken to reflect the changing economic fortunes of the country.

The review should have made it possible to structure the new science curriculum to reflect the economic realities of the country by making less demands on the schools in terms of equipments and materials, or since it is a product of direct government moves, it should ensure the presence of the materials needed to enable its effective implementation.

The learning by doing method of teaching and learning science, under any sort of modern economy, is undeniably expensive, because of the amount of materials it requires to carry it out.

The new science curriculum will probably operate best in educational situations where it is up to the schools to adopt a unique style of teaching science to their students. In the Nigerian case, the curriculum and consequently the techniques to be used in teaching it are legislative acts. This means therefore all schools, regardless of status of their equipments, have to teach science this way, although not without some reservations from some schools. As the Principal a Science School noted,

> "There is a demand for additional teaching materials and equipment since the laboratories for example will now be required to conduct advanced experiments. Some of the material may not be available. So we have to buy more. Then we have to be more strict in the selection of the teachers now to ensure that we get the best teachers who can teach to the requirements of the new syllabus. So only the best and most qualified teachers can come to teach. But that is saying we need to select the best teachers and pay them higher renumeration." (Interview 8/10/1986)

But although Science Schools, by the virtue of their specialist position can feel a measure of confidence in implementing the curriculum, conventional schools do not. As the Principal of a girls secondary school also observed,

> "Science teachers complain a lot about this new national policy. And their complaint is mainly that of lack of equipment and materials. And this is the result of the economic situation of the country, rather than the syllabus itself. The teachers themselves are handicapped in the schools. Equipment and materials and textbooks are scarce. If these things are available - equipments, materials, textbooks, - the teachers will not complain." (Interview 15/10/1986)

Some of the problems are simple, structural or organizational but quite serious. As a teacher complains of his laboratory

> "Look at this refuted school (established 1927). There is no electricity here for the last three or four years. Somebody stole the electrical fitting or something and the school has remained like this since. So how can a

> Physics lab remain without electricity? Just imagine!" (Interview 15/1/1987)

Thus although the new policy treats all schools in Nigeria the same and expects them to be equipped to carry out its objectives, sharp differences that exist between the localities of the schools makes implementation, and consequently achievement of objectives uneven.

6.3.6 Curricular Implications

The most significant curricular implication of the new science curriculum is its explicit and implicit use of the principles of Gestalt Psychology. In explaining the psychological basis for the NSSSP course which was the same as in the new science curriculum, one of its developers, Ivowi (1982a p.18) explains that the Gestalt Psychology provides a framework around which the discovery learning technique the new science curriculum advocates is structured. But the appropriateness of this approach to structuring the curriculum has not been explained, neither has any indications been given about the baseline psychological data of the learning process of the Nigerian child, which may provide any justification for using this approach.

This is a significant issue, and its full implications need to be considered. Quite a few investigations in many countries on the nature of cognitive demands of various science curricula which are based on specific learning theories show discrepancies between the various demands made on the children when being taught certain concepts in science, and their ability to integrate these concepts into their overall conceptual schema (Herron 1975, Lawson and Renner 1975, Haley and Good 1976, Shayer 1978, 1979, Shayer and Adey 1981, Ohuche and Otaala, 1981). In most cases, there were indications that failure to subsume scientific concepts was a result of not reaching specific stages of development, consciously or unconsciously assumed by the science curriculum.

For instance, Herron (1975) quoted studies in the US and Australia indicating discrepancies between conceptual development and cognitive demands of the Chemistry curriculum. Similar findings were reported by Lawson and Renner (1975) and Haley and Good (1976) in the American schools.

In England, Shayer has constantly pointed out the need to tailor the psychological assumptions of the Nuffield science courses to the cognitive levels of the students for whom they are aimed at (Shayer 1978, 1979, and Shayer and Adey 1981).

The issue is of sufficient concern to African science educators to make the administration of the Science Education Programme for Africa (SEPA) commission a study to determine how the psychological theories may affect the structuring and subsequent learning of science especially taking into consideration the social environment of the African child. While the study was not empirically based, the extensive review of various works did show similarities with Western education contexts, namely not all children pass through the various stages of development as envisaged by various psychologists, especially Piaget, and that this will have consequences for the way science education is structured for the African child (Ohuche and Otaala 1981).

The implications of structuring the Nigerian science curriculum around the expectations of any psychological theory of learning thus need to be justified. This should be useful to teachers who would want to determine, if their difficulties for instance, in communicating scientific concepts to their students could be attributed to the lack of cognitive readiness of the students to perceive that concept at the level expected by the science curriculum, or due to their own interpretation of the science curriculum.

Also, the science curriculum reflects the same view as contained in the pattern of learning influenced by most of the science education reform movements. This includes structuring science curricular materials around the learning categories of cognitive, psychomotor, and affective domains. However, there was nowhere in the science curriculum where the limitations of the method of learning it advocates are acknowledged for a culturally diverse country such as Nigeria. As a consequence of this, the curriculum makes assumptions about the abilities of the children that cannot, or have not, been properly rationalized.

6.4 Section IV: Intrinsic Analysis Of The New Science Curriculum

In moving towards gaining an understanding of the nature of the new science curriculum, an intrinsic analysis of the curriculum was carried out. This is necessarily restricted to a study of the syllabus guidelines, which, as I explained previously, was the only official document on the new science curriculum at the time of the analysis.

6.4.1 General Aims and Performance Objectives

Each science curriculum is divided into four sections: performance objectives, content, activities, and notes. The contents are interpreted through the activities and the performance objectives.

In the general description of the entire curriculum, its developers borrowed its classifications of cognitive, psychomotor and affective clusters of behavioural objectives from Bloom's Taxonomy of Educational Objectives (Bloom and Krathewohl, 1956). This was originally divided into six broad categories of Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. For the purposes of this analysis, these objectives are re-arranged into the following categories

6.4.1.1 Cognitive Domain

This involves not only ability to recall bodies of consolidated knowledge, but also how to utilize that knowledge in different contexts to emphasize understanding, application and interpretation. The various sub-divisions are:

a) Knowledge: this includes the recalling of information, including principles and generalizations, trends and sequences and so on
b) Comprehension: this lies in the domain of translation, interpretation and extrapolation
c) Application: ability to apply a principle to a new situation where the learner must first select appropriate principle
d) Higher abilities: this includes analysis, synthesis and evaluation.

6.4.1.2 Psychomotor Domain

The objectives in this domain emphasize muscular or motor skills or ability to manipulate materials. These, in some cases, may include writing or drawing or other pencil and paper activities.

6.4.1.3 Affective Domain

These objectives are more difficult to evaluate and measure, but they are nevertheless quite crucial to attainment of science objectives. This is because objectives in this category deal with interests, attitudes, appreciations, values and emotional sets of biases, which, if properly nurtured, could enable a more effective understanding of the scientific process in children.

The new Nigerian science curriculum expects its objectives to be achieved through these clusters of objectives. As explained by its developers,

> "One important reason for stating performance objectives is that they will guide teachers in self-evaluation of their own teaching and the achievement of their students. Teachers should note that the performance objectives presented in this curriculum are not exhaustive, they should add new ones as deemed necessary, especially those performance objectives in the higher cognitive level and psychomotor and affective domains." (NERC 1985a p.ii)"

The expectation teachers should carry out these tasks again assumes they are aware of the balance in the cognitive, psychomotor and affective expectations recommended by the science curriculum.

But effective incorporation of these three broad learning objectives in any science lesson requires a level of awareness associated with specific professional training. Not all Nigerian science teachers have this sort of training. A typical response from a teacher in a Science School which summarizes the general situation was

> "Personally for me there is this question of lack of equipment. There is also the question of lack of experience. Sometimes I lag behind as regards the rate at which I go which I know arises because of my lack of teaching experience. That is a problem." (Interview 25/2/1987)

The issue thus is not whether the teachers are willing to design more performance objectives in these categories of learning, but whether they can actually do so. This needs to be carefully considered if effective judgements can be made about the quality of the interpretation of the teachers of the new science curriculum. In any event, it would seem teachers rely not on the curriculum for derivation of their objectives, but on their own understanding of the objectives of teaching their various subjects. As a Physics teacher in a Science School explained,

> "For every lesson I try to sit down and write some certain objectives. Whenever I come to a lesson I try as much as possible to achieve the objectives or the aim of the lesson. But then sometimes you find that I don't become successful. Setting up of objectives (as in the new

syllabus) is okay, but it is not necessary that you achieve the objectives." (Interview 25/2/1987)

Indeed employers are quite aware of possibilities of teachers not using the precise strategies recommended by the new science curriculum. As the Executive Secretary of Science Board commented,

> "In all our schools now everybody uses his own techniques. Those who are trained probably use a bit of the techniques they learned from their training." (Interview 23/8/1986)

What did emerge after various discussions and structured observations of many science lessons is teachers do not feel the new objectives will guide them any better in their lessons than the former syllabus (see Chapter 7).

Further, the analysis of the Nigerian science curriculum using these three broad clusters of objectives proved difficult because of two main reasons. First is the lack of clarity, precision and consistency with which leading words were used to describe the performance behaviour expected from the students.

For instance, in Biology Year 1 (SS1), a performance objective states "students should identify the sun as the ultimate source of energy" (p. 3) In Year 3, another objective states they should be able to "identify dominant and recessive characters" (p. 61). It is clear in both these instances the "identification" requires a significant amount of explanation. However, in the same subject in SS3, another objective states the students should be able to "identify chromosomes in permanently prepared slides of cells" (p. 61) The use of the word "identify" here implies response to a visual stimuli, and thus shows the inconsistency with which the word is used in the curriculum. This is not an isolated case, and similar instances are encountered throughout the three science subjects.

In another instance, it is not clear whether the performance objective expects the student to behaviourally prove learning has taken place. For instance, in Chemistry (Electrolysis, p.11) one of the performance objectives states the student should be able to "observe that electrostatic charges have positive and negative charges." In this case, it is not clear precisely what is being evaluated from the student's point of view, and how any achievement can indeed be evaluated (especially as it is not an activity)

Similar problems are encountered in the performance objectives where the student is expected to "recognize". For instance, in Biology (Properties and Functions of Cells, p.24) an objective states students should be able to "recognize that some of the energy liberated is converted into heat"; another is they should "recognize that several processes are co-ordinated and influenced by growth hormones and auxins" (p.26). In these two cases, and others using the word "recognize" it is not clear as to what it precisely means; in some objectives it appeared in the same context as to "explain." In others it was used as in to "separate" (or distinguish between two variables/concepts), and no examples are given in the syllabus.

Secondly, these problems of lack of clarity of the performance objectives are further confounded by the large number of verbs used to describe many of the performance objectives; whereas few would suffice. For instance, in Biology SS1 alone, 21 leading words were used to describe the total of 102 stated performance objectives. Most of the words used appeared only once (e.g. “interpret” as in p.10: “students should be able to interpret graphs showing ecological factors of an area”).

There would also seem to be a virtual one to one relationship between the performance objectives and the activities. This creates uncertainties about the actual purpose of the performance objective: at one stage it would seem as if it is aimed at evaluating the activity, while at another it would seem to be aimed at evaluating subsumation of a principle. For instance, in Physics, under Heat Energy, a performance objective expects students to “determine the melting point of a solid” (p. 25), while its corresponding activity states the activity should “determine the specific heat capacity of solid.”

From the use of the same operative word “determine” it is thus not clear how the performance objectives differ from the activity. It is of course appreciated the activity is the main mechanism through which the performance objectives are expected to be attained. But not making explicit differences between the two result in lack of clarity as to what the teacher is expected evaluate - perfection of the procedures of the activity, or assimilation of the concepts behind the activity (which, it must be assumed, is reflected by the performance objectives).

In a similar situation, Shayer and Adey, in their analysis of the Nuffield Combined Science Curriculum noted that the curriculum does not have behavioural objectives spelled out for each activity of each unit. However,

> “from the general description of what is expected to be achieved by each activity, and by the simple expedient of asking ‘What is the point of doing that?’, one can specify the implied objectives closely.” (Shayer and Adey 1981 p.50)

This deductive strategy does not apply well in the Nigerian case. The activity, as made clear by the Nigerian science curriculum developers, is a group effort; involving both the teacher and the students. And in this situation, not every student is necessarily involved in the activity: some may be part of the group, but as observers. As Ivowi (1982b p.9) states,

> “The project provides as many complementary activities as possible; the intention being to emphasize and possibly make permanent, the related concepts being treated. It is not expected that each student will actually perform all the experiments under the activities. One hopes that the teacher can arrange for the class to be exposed to all the activities by a strategic sharing of activities among the students in the class. Through organized discussion students may share in the discoveries of their classmates.”

The performance objective, on the other hand, is aimed at enabling the individual learner to make a personal statement about their understanding of a scientific principle just learnt. Thus using the objectives of the activities does not provide an adequate basis for determining whether the child can be expected to personally display an understanding of the concepts to be covered by the activity. This is therefore all the more reason there should be differences in the level of expectations between the outcomes of the activities and what the performance objectives set out to measure. Lack of this delineation makes interpretation of the entire science curriculum not easy in some instances.

6.4.2 Relative Emphasis on Content, Techniques and Principles in all the Science Subjects

The performance objectives in all the three subjects are analysed at the same time for comparative purposes, as well as to show the relative expectations of each subject according to the three domains of learning - cognitive, psychomotor and affective. The strategy involved counting all the performance objectives in the three subjects and placing them according to the leading words used to stated each in the category that best suits the expectations of the objective.

Though most objectives fall into one category or other, the distinction between the behaviours that can be fitted into each category proved difficult to make with absolute precision, especially between performance objectives in the "comprehension" and "application of higher skills" realms in the cognitive domain, so divisions between the two categories in this analysis should therefore be treated with caution. Nevertheless, the categorization done on this basis enables judgements to be made about the relative emphasis of the science curriculum.

The performance objectives of the three subjects are shown in Figure 6.1

---GRAPH--

Fig. 6.1. performance objectives of the three subjects

From Figure 6.1, in a distribution of the performance objectives into Cognitive (COG), Psychomotor (PSY) and Affective (AFF) categories, all the subjects showed a high presence of performance objectives stated in the cognitive domain. Biology has the most with 316 objectives stated as to merit categorization in the cognitive domain. This is followed by Physics with 203 objectives in the same domain. Chemistry with has 163 objectives in this domain making it correspondingly less than the other two.

Similar distribution is also noted in other domains with Biology having 21 psychomotor objectives while Physics has 38 and Chemistry 13. Another common element binding all the three subjects in the Nigerian science curriculum is the marked absence of any performance objective stated in a way aimed at measuring the affective domain. Quite a few of the performance objectives deal with attempts to instil skills in students which are often associated with scientific behaviour or techniques, e.g. infer, observe, hypothesize. None of the performance objectives in all the three subjects aimed at affective domain; i.e. in terms of an emotive commitment to science such as interest, appreciation and so on.

But clearly a caution is needed when interpreting this finding. This is because it could be argued instilling the skills associated with scientific behaviour is an attempt to evoke interest in science. For instance, honesty can be combined with observation and reporting results. Neatness can be instilled when graphs (as mechanisms of interpretation) are drawn. The arguments in this case can be pretty grey and thin, and definite conclusions not easy to be made because it tantamount to going beyond what the curriculum developer actually writes down as intentions, to what the analyst thinks is probably (or should be) meant by a particular set of performance objectives.

This analysis of the performance objectives shows an interesting pattern in the variety of intentions envisaged for the science education of the Nigerian child. This is more so because of the explicit as well as implicit aims of the Nigerian science curriculum were it will centre on discovery method of learning with emphasis on the development of analytical skills and scientific attitudes.

A second level of analysis of the performance objectives in the Nigerian science curriculum, perhaps not surprisingly, shows a leaning towards evaluating the basic knowledge of the learners even in the cognitive domain. Figure 6.2 shows the result of further analysis of the performance objectives in the cognitive domain particularly in the levels of Knowledge (K), Comprehension (C), and Application and Higher Skills (A).

Even in such micro analysis of the cognitive domain, Biology leads, with 203 performance objectives stated at the knowledge level. This is followed by 98 knowledge based objectives in Chemistry and 92 in Physics. But in the level of comprehension, there was a closeness between Biology with 104 objectives and Physics with 91 objectives which are all higher than the 41 objectives in Chemistry.

Interestingly, in a similar analysis of performance objectives from various sources in literature in the United States from 1918-1972, Ogden and Jackson (1978) discovered that

> "The most important objectives for secondary school biology teaching...were those from the knowledge category relating to "specific topics in biology." Although these objectives remained the most cited until subperiods 4 (1945-1957) and 5 (1954-1964), they declined steadily in number of citations over the entire 55 year time period." (Ogden and Jackson 1978 p.300)

They proposed that this occurred because of historical (on the part of the society), and evolutionary (on the part of the Biology curriculum) forces which saw an emphasis of knowledge of particular in Biology teaching in the earlier time periods covered by their study. At later stages, new thinking about the role of science in cognitive development prompted a realignment of objectives so that they now emphasize "scientific methods of thinking." It would be interesting to carry out such historical analysis in relation to the development of Nigerian science curriculum; although from the evidence provided, it would appear "knowledge of particulars", not only in Biology, but also all the science subjects is emphasized more than scientific methods of thinking.

Interestingly, an earlier analysis by Ogden (1972) along similar lines and covering similar time period in Ogden and Jackson (1978) discovered that

> "The most important objectives for secondary school chemistry teaching, as indicated by the frequency of appearance in periodical literature of

> the 1918-1972 years, were those relating to the "scientific methods of thinking". Prior to mid-1920's, authors stressed what they call "qualities of thinking" or the "new ways of thinking." (Ogden 1972 p.244)

The observations of Shayer and Adey (1981 p. 85) to the effect that in Biology "much descriptive botany involves little application of mathematical modelling beyond notions of central values...and variation.." seem to manifest themselves also in the Nigerian science curriculum. This is because Chemistry and Physics have the highest performance objectives stated at the application and higher skills level. Chemistry has the highest objectives at 24, while Physics has 20. Biology trails with only 9.
jeka
On looking at the individual performance objectives as stated in Chemistry and Physics, the analysis discovered while the former may indeed have higher number of intentions in the application level, this could be because of the ambiguity in the statement of the objectives in Chemistry (and, subsequently, other subjects as well). For instance, only 4 objectives at this level in Chemistry were calculations. Physics, however, has 11 objectives requiring calculations (e.g. "calculate the power in watts given an applied force and the time it takes to produce a displacement": p. 5).

Perhaps not surprisingly, Biology has no calculations in its performance objectives at the application level (or any other). This level was taken up with objectives aimed at enabling the student "to use knowledge"; for instance "use the knowledge of energy losses in the ecosystem to explain the pyramidal shape of feeding relationships" (p.13). This, however, remained the only instance in which an objective is stated in this particular mode in the Biology curriculum. Other words used in the same level include "compare", (e.g. "compare reproduction in fish, toad, reptile, bird and mammal": p.51) "estimate" (e.g. "estimate the proportion of mineral salt present in the fresh water habitat": p.38) and "correlate" (e.g. "correlate the effect of rainfall or any other sources of water and evaporation to the changes in a marsh": p.39).

Thus the emphasis of the Nigerian science curriculum would seem to be on the acquisition of basic scientific knowledge. Other traits learning most commonly associated with learning science, and as declared in the rationale of the curriculum, such as the development of specific attitudes were not emphasized, while scientific techniques where found only to a limited extent. This would seem to be recurrent in cases where an emphasis is placed on the expectations of the science curriculum in social development. For instance Lewin (1981) also carried out an analysis of the Malaysian Integrated Science curriculum materials whose major intentions were to reduce emphasis on the recall of factual information in favour of encouraging the development of affective, psychomotor and higher order cognitive. And yet despite this intention,

> "it is surprising to find that 53% of section objectives are specified at the knowledge level of the cognitive behaviour whilst only 18% of general objectives are." (Lewin 1981 p.179)

Lack of distinction between curricular rhetoric and its structural reality would therefore seem to characterise some certain aspects of science education curricular reforms.

6.4.3 Relative emphasis on content, techniques, principles and processes in the subjects across the years

Analysis of the distribution of the performance objectives across the years in all the three subjects of the Nigerian science curriculum does not reveal any specific pattern to show the "concentric" nature of the science curriculum. In any event, the term "concentric" was not properly defined in the curriculum as to make it explicit what was meant and what teachers should look for in the science curriculum which characterizes its concentric nature. As the rationale of the approach used explains,

> "In the approach, the concepts to be taught are arranged in such a way that they run throughout the three-year course, the concepts being discussed in greater depths as the course matures over the years." (NERC 1985a p.ii)

But "greater depth" here needs to be made clear: is it in terms of making more cognitive demands on the learner? In which case, how can we know whether the proper level of demand on the learner is being made? Or is it in terms of more contents in the subject as it goes through the years? The analysis of the performance objectives in all the three science subjects does not provide a clue as to the "concentric" nature of their design - at least on these two questions.

The analysis of the performance objectives across the years did reveal a surprising pattern in the level of intentions of the science curriculum over the three years. This is shown in Figure 6.2.

---GRAPH--

Fig.6.2: intentions of the science curriculum over the three years

In all the subjects across the years, as indicated by Figure 6.2, the same pattern of the distribution of the performance objectives as in the individual subjects is observed. There are also no differences in the wordings of these objectives across the subjects and years. For instance, in Physics, one of the performance objectives under Heat Energy (p.6) in SS1 was students should be able to "explain conduction, convection and radiation in terms of the kinetic molecular theory". In the same subject under Electric Fields, an objective was the students should be able to "explain the basic principle of the potentiometer circuit" (SS3 p.41). Although both were aimed at measuring different abilities in the students, the wording does not reflect this.

From the Figure 6.2, it is interesting to note Year 2 has the highest number of performance objectives in all the science subjects, with 293 being stated in the Cognitive domain, while Psychomotor has 40. This is a sharp contrast to the distribution of the same performance objectives in Year 1. And it is also less than for Year 3. This is quite significant for two reasons.

The Nigerian senior secondary school science curriculum is expected to build up on the Junior Secondary School Integrated Science course which the students must have followed. From the distribution of the performance objectives in Year 1 of the senior science curriculum, it is not clear whether this may be considered an effective building up of the concepts previously learnt in the last year of the Junior Secondary School's Integrated Science.

Year 3 is significant because it is from this stage students are expected to go directly to the university and begin foundation courses as the start of a four year degree programme in sciences, as planned in the new National Policy on Education (Nigeria 1981). It is not clear whether the developers of the Nigerian science curriculum feel the SS3 level of expectation as presented in the present science curriculum might be adequate preparation of students for this task.

Thus priorities between the years in terms of the performance objectives of all the three science subjects are not shown. If anything, they show a general decrease in year three in all the domains, the objectives in the cognitive domain remaining close to those in the first year. Though probably not intended to encourage emphasis on acquisition of cognitive behaviours assessed in the final examination, a reduction in the frequency with which the psychomotor objectives are specified, as well as the total absence of affective objectives might be thought to encourage precisely this behaviour (which the new science curriculum sets out to eliminate, or at least, reduce).

The relative distribution of the performance objectives in all the science subjects and across the years is summarized in Figure 6.3.

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Fig. 6.3: relative distribution of the performance objectives in all the science subjects and across the years

From Figure 6.3, it emerged the second year in all the three subjects (B2, C2 and P2) has more performance objectives than year 2 or year 3. Biology throughout the years maintained the highest number of cognitive performance objectives. But in terms of overall distribution of the objectives in all the three domains (cognitive, psychomotor and affective) there was a close similarity between Chemistry and Physics. It is not clear, however, whether this was a reflection of the principles behind Chemistry and Physics as perceived by the curriculum developers, or such similarities occurred by chance in the way the two syllabuses were written.

6.4.4 Section Analysis: Biology - Genetics Conceptual Theme

In order to determine further the internal consistency of the new science curriculum in terms of its structure, expectations and probable cognitive demands on the students, another level of analysis was carried out on a representative unit. The unit chosen for this was Genetics in Biology. No specific criteria was used in its selection, but from an investigation of all the three syllabuses, it would seem to be fairly representative of the intents of the new science curriculum.

According to the conceptual structure of the Biology curriculum given in the syllabus, Genetics is one of the seven 'big' ideas of Biology to be treated in the curriculum. The concepts of the topic (i.e. genetics) were not restricted to one particular location of the Biology curriculum according to the structure given in the Biology curriculum; rather, they are spread over the three years. The precise description of the conceptual structure of the unit is given below.

Genetics
Some variations are inherited, others like those acquired during an organism's lifetime are not. There is a genetic basis, with a recombination of genes at sexual reproduction in the case of inherited traits. The transmission and expression of characters in organisms is the object of this section. It is expected that students will recognize the applications of the principles of heredity in agriculture and medicine.

Year One
Ways of improving crop yield - genetic engineering

Year Two
1. Cell Structure and Function (genetic material)
2. Meiosis

Year Three
1. Transmission and expression of characters in organisms
2. Chromosomes: the basis of heredity
3. Probability in Genetics
4. Applications of the principles of heredity in agriculture and medicine. (NERC 1985a p.vii)

The first observations about this scheme is it is just a list of topics without any structural unity with each other. Another issue raised by this scheme is the appropriateness of the expectations placed on the students in each year. It is contentious whether the concepts of genetic engineering should come before elementary concepts are learnt about the structure of the cell. Yet this is what seems to be intended in the Nigerian curriculum. This is because in Year I a way of improving corp yield was suggested - genetic engineering. And yet cell structure and function did not appear until Year 2.

An analysis of the entire Year 1 Biology curriculum shows one topic which may have a conceptual basis in Genetics, and that is "Relevance of Biology to Agriculture" (p.6). While the contents of the topic suggest sub-topics including one dealing with food production and storage, none of the seven performance objectives, five sub-topics and five activities all under the main topic dealt with the topic as a concept in genetics, which is clearly implied by the conceptual theme given earlier.

The content of the sub-topic of food production and storage did suggest "ways of improving crop yield" as a basis of discussion. It is however not suggested whether this should be taught from the genetic point of view (rather than sociological; for instance from the perspective of agricultural education thus providing a general introduction to the conceptual theme). If this is to be the case, it is difficult to imagine how it could be done successfully in the absence of prior knowledge of the students about the cell itself as listed in the Biology curriculum. If the topic is not meant to be taught from this perspective at this stage, then the use of the phrase "genetic engineering" suggesting an approach, can be misleading to teachers.

The concept of the cell made its first appearance in the Biology curriculum in Year 2 (p.22). While there are many sub-topics dealing with the cell in virtually every context (such as growth, movement and reproduction) the elementary concept of genetics does not seem to be included anywhere in the units; although an objective states the students should be able to “identify the following components of the cell: cell, wall, cell membrane, cytoplasm, cytoplasmic inclusions and nucleus” (performance objective number 5). Moreover, there was no discernible linkage between these topics and activities and those in Year 1 which covered Relevance of Biology to Agriculture in the activities accompanying the topic.

Finally, it would seem all the concepts of genetics were placed in Year 3. It is only here the concept of the chromosome as the basis of heredity was introduced; as well as the applications of the principles of heredity to agriculture and medicine. The most interesting point in this level is the expectation the students should carry out Mendelian experiments, raising the same issue about cognitive demand at that level.

From the analysis of the conceptual theme of genetics in the Biology curriculum, there was no evidence of the presence of the concept of genetics in Year 1 and Year 2 of the curriculum, despite claims that due to the concentric nature of the entire curriculum, such presence is to be noticed and emphasized to the students throughout the three years. This means claims by the science curriculum that it is arranged in a concentric nature must be taken with caution.

This is because firstly, the implied conceptual unity of the big ideas in each subject does not seem to be maintained (taking Biology as a typical example). Secondly, no awareness is also displayed of the relationship between the level of the senior secondary school, the age of the students, and the probable cognitive demands of scientific concepts on students. As such, no justifications are provided for assuming all concepts have the same “entrance fee” at all the three senior school levels.

The findings in this analysis obviously have a direct consequence for teachers. It is possible to envisage a situation where teachers attempt to teach a certain topic to students, without realizing the possibility of a mismatch between the concepts they are attempting to teach and the cognitive level of their students, and what other factors might further affect the situation.

Moreover the declaration about the concentric structure of the science curriculum implies all concepts have the same currency, and that teachers can distinguish between the different conceptual denominations in the science subjects. This, however, was too optimistic, and is reflected by a Biology lesson I observed which went as follows:

The class is SS2. The topic is a study of Hydra. Teacher comes into classroom and writes Hydra on board, and proceed to give an eloquent lecture on Hydra for the next 25 minutes. Details are given about its cellular structure, general anatomy and physiology with the teacher using a well labelled drawing on the board to explain his point as he goes along. After 25 minutes he pauses and asks if there are any questions. A student raises his hand

Student: Sir, what is epithelio-muscular cell?
Teacher: It is the main muscle structure that provides support for the

	Hydra
Another Student:	Sir, what is interstitial cell?
Teacher:	These are germinal cells and give rise to sperm and eggs for reproduction in the animal

After the lesson I talked to the teacher:

Adamu:	That was quite an interesting topic. Is it the first time you taught it?
Teacher:	Yes. We did Paramecium previously
Adamu:	When did you cover cells with them?
Teacher:	They have not yet done anything on cells. But we will be doing cells next year
Adamu:	Do you have slides of Hydra to show them?
Teacher:	Unfortunately, no. I don't think we have it
	(Diary 18/11/1986)

The teacher was clearly not aware he was teaching a topic which requires an extensive previous knowledge of prior concepts from the students (cells, to build up to a topic on cellular organization). And since the students have no pre-conceptual basis (knowledge of function of cells), the teacher found it difficult to present this class of concepts (function of cells in an living organism) with ease - as reflected by this sample dialogue between the teacher and two students.

The SS2 Biology syllabus does include Hydra as a topic, but did not indicate the limit for its coverage. This teacher's strategy was the safest option for him. By giving the topic the "full treatment", he has ensured he provided the students with all the information they need to adequately answer the topic during any examination. The concentric nature of the subject as arranged in the new curriculum is subsequently lost on many of the teachers.

6.4.5 Correlations between aims and performance objectives

In order to go beyond the performance objectives stated, another level of analysis was carried out to determine the extent to which the performance objectives reflect the overall aims of the Nigerian science curriculum. This becomes necessary because of the curricular (from the perspective of the curriculum developer), and analytical (from the perspective of the analyst) assumptions that achievement of the performance objectives will somehow mean an achievement of the aims of the science curriculum as envisaged in the developmental aspirations of the curriculum.

The aims for each of the three science subjects chosen for this research (Biology, Chemistry and Physics) have already been outlined previously. These aims can be rearranged so as to obtain a list of their individual characteristics together as given below (not in any specific order):

1. Provide basic scientific knowledge
2. Relate science subjects to each other
3. Provide science for further education
4. Provide science for employment after school
5. Enable application of science to social problems
6. Enable industrial application of science

7. Enable acquisition of reasonable and functional scientific attitudes
8. Stimulate and enhance creativity.

The performance objectives in each science subject were then analysed individually to determine where a certain objective fits in with the above list of overall aims. Again, as usual, this classification must be treated with caution because of the difficulties encountered in allocating the performance objectives into each of these broad category of aims.

The analytical guide used is the statement of the performance objective. For instance, if an objective asks for explanation, recognition, stating, or description, it is placed in the aim of testing basic knowledge. Similarly, any objective which seeks to instil a scientific mental process e.g. infer, hypothesize, observe, deduce, or verify is placed in the aim of testing scientific skills and attitudes. But a further caution is necessary here.

The emphasis of the analysis has always been on what the statements say by themselves, not what they might imply. Thus while the overall analysis does not reveal performance objectives in the affective domain (to appreciate, to show interest, to like, to be excited, to look forward to), there are quite a few aimed at instilling scientific attitudes (rather than attitudes to science). It is to this latter categorization performance objectives with words such as infer, hypothesize etc were placed. Placed in this category of scientific skills and attitudes are also those performance objectives stated in the psychomotor domain (to demonstrate, to draw, to write, to generate, to manipulate etc)

Placing the performance objectives in the categories of some of the aims proved also not entirely easy. For instance, where does the analyst draw a line between basic knowledge with a view to further education, and similar knowledge to be used for immediate employment?

This is a significant point because the academic needs of those who continue with their education, and those for whom the secondary school is the highest form of science education they are likely to receive, are quite different. The Nigerian science curriculum does not make this distinction; nor does its developers provide any clues as to how this could be done by the teachers, if only to ensure some sections of the student population, with no aptitude or interest in further science education, but nevertheless who, it is felt, need education in science as part of their training for life, are not unduly burdened with difficult material during their senior secondary school years which may end up alienating them from science.

For the purposes of this analysis, therefore, the aims of providing basic knowledge, and science for further education are combined; the rationale being those who wish to continue must have this basic knowledge.

Also, from the onset, it has never been clear to what extent some of these aims can be expected to be reflected in the performance objectives. Moreover, not all of these aims were reflected in all the science subjects. For instance, only Biology has the aim of enabling students to acquire “reasonable and functional scientific attitudes” (although it was also not clear what the criterion for “reasonableness” can possibly be in this situation).

Also, only Chemistry and Physics contain the aim of industrial application of science (Chemistry) and technological application of science (Physics). Interestingly enough, only Biology contains the objective of relating scientific knowledge to everyday life. The picture emerging from this is a lack of co-ordination between the various aims of the individual science subjects in the Nigerian science curriculum.
The analysis of the distribution of the performance objectives in the general aims of science according to the scheme outlined above is shown in Table 6.1

Table 6.1: Distribution of Performance Objectives in the new Science Curriculum

	Performance Objectives		
Aim of Science	**Biology**	**Chemistry**	**Physics**
1. Basic Knowledge and Further Educ.	291	159	235
2. Science for Society	34	7	-
3. Scientific Skills	17	-	19
4. Science-to-Science	1	-	-
5. Science and Employment	-	-	-
6. Science and Industries	-	6	-
7. Science and Creativity and attitudes	-	-	-
Totals*	**343**	**172**	**254**

(Figures here are all the performance objectives. Blanks indicate absence of any objective to that category)*

From Table 6.1, it is perhaps not surprising, considering earlier trends, to note a close relationship between Chemistry and Physics even in the attempts to realize the aims of the individual science subjects. About 291 performance objectives in Biology, and 235 in Physics were aimed at the basic knowledge level, while Chemistry has 159. All the three subjects, except Physics have performance objectives reflecting science in the society (see below for further discussion and analysis of this variable).

Considering earlier trends, it is not surprising to discover none of the three has objectives aimed at either scientific creativity or attitudes. And of the three subjects, only Chemistry has some objectives relating to industries (and all virtually in one topic - Applied Chemistry; which, as part of Industrial Chemistry, has 3 performance objectives out of a total of 9 for that section.)

Also, although it is understood this curriculum is a "separate sciences" curriculum, nevertheless it is interesting to note the marked absence of other subjects in each of the three science subjects. Only Biology would seem to do this. This is contained under the first topic of Biology and Living things, where performance objective number 18 (p.3) states students should be able to "relate conversion of energy to first and second laws of thermodynamics." This would presume a basic knowledge of the laws normally found under Physics.

Before any definitive conclusions can be drawn from these findings, it should perhaps be stated it is acknowledged there was no reason to suppose there should be a one to one relationship between the performance objectives and the overall aims of teaching science as stated in the curriculum.

Yet the analysis shows little correlation between a majority of the aims and an equal majority of the performance objectives; moreover, the curriculum itself did not make any attempts to make these correlations. Thus teachers organizing their work solely on the strength of the performance objectives are likely to assume wrongly they are providing the students with experiences to enable them to attain all the aims of science as defined in the Nigerian science curriculum.

6.4.6 Aims for Science Education

For a curriculum with the broad rationale of enabling Nigeria to become technologically self-reliant, it is surprising to note the marked absence of the social application of science in the Nigerian science curriculum in the performance objectives. In an attempt to determine this, the activities in each of three science subjects were themselves analysed with the expectation they may provide clues as to what the curriculum developers feel is the social relevance of science, through that particular subject.

Again, here as before, it is necessary to distinguish between what the performance objectives and the activities each set out to do. As previously explained, the latter are seen in this analysis as a function of the group, rather than the individual which characterizes the former. Because of this analytical dichotomy, there is a difference in the number of science-society mentions in both the performance objectives and the activities, as each was considered separately.

In all the activities of all the three science subjects analysed, there were less than 8 instances in which science and society interactions were explicitly featured. It was also not acknowledged in the same degree in all the three subjects.

The actual distribution of these science-society interactions in the activities show that Biology has at least 5 science-society activities (p.13., p.18, p.20, p.43, and p.44). Physics has at least two (p.17 and p.47), while Chemistry has what are called Literature Projects (p.7, 12, 21, 23, and 26) and Experimental Projects (p.6, 7, 8, 11, 13, and 26). It is not precisely clear what these Projects were actually supposed to achieve. For instance, a Literature Project under Electrolysis simply stated: “Evolution of Naming (Nomenclature) in Chemistry” (p.12). No further explanation was given as to what is being expected.

However, the Chemistry Experimental Projects were more revealing. It would seem they are aimed at using local materials in Chemical investigations (it is for this reason these Projects are considered societal in this analysis). For instance, under Acid-Base Reactions, the Experimental Project stated: “a) Titration using extracts of flowers as indicators. b) Titration using water from different sources as solvents, e.g. tap water, rain water and well water” (p.13). While probably aimed at providing Chemistry education with a distinctive “local” flavour, these projects are nevertheless redundant, especially as they do not provide any specific directions during Chemistry teaching.

Some of the emphasis in the applications of science in society as given in the Nigerian science curriculum are more unusual. For instance, in Physics, an accompanying note to the activity on Projectiles stated: “the application of projectiles in warfare should be highlighted” (p.17) - a highly contentious example to draw from. The tendency could be towards emphasizing the examples given in the syllabus without the teacher working out others that transmit the same principle or concept in a less distorted way. An example of this situation, interestingly enough, dealing with the topic of projectiles, is recorded in my discussion with an Asian teacher:

Adamu: What specific objectives do you formulate for your subject (Physics)

Teacher: Objectives are already in the mind of the teacher, and that is what you expect students to learn

Adamu: Well yes, but what about the objectives in the syllabus? Do you follow them?

Teacher: There are no objectives there.

Adamu: But there are. These ones here (opens the *Physics syllabus* and shows to the teacher)

Teacher: (getting agitated and looking at tape recorder). These are topics. Anyhow I feel sometimes you need an objective with practical application. May be you want to ask me about practical applications.

Adamu: Well alright. What topic did you do recently?

Teacher: It was projectiles.
(Objectives include: Students should derive the range, maximum height and time of flight)

Adamu: Tell me how you taught it.

Teacher: First of all projectiles is a topic that is not so interesting. So I begin by stimulating their interest and telling them about the practical application of projectiles. The use of them in our lives, especially in war. I gave them examples of air attacks where bombs are dropped on enemy targets. To make it more relevant to them I told them some may join the air force at NDA (Nigerian Defence Academy) and see the practical use of projectiles. After the topic I asked them questions about that and set a problem for them to solve

Adamu: So the only way to find out whether theseobjectives have been attained is by asking the students?

Teacher: Yes.
(Interview 22/10/1986)

The teacher clearly used this example because it was the one suggested in the Physics syllabus. He has not demonstrated an attempt to use other examples that put science in a lighter shade and demonstrates the use of science in society more constructively.

The general picture that emerges from this is neither the performance objectives nor the activities set out to make definitive connections between the science learnt by the students in the schools, and its rational, wider application in the society. In all the three science subjects analysed, there does not seem to be any specific pattern of linkages in the distribution of the science-society interactions across either the subjects or the years.

But by far the most significant finding of this analysis is the total absence of orientations to the labour market in the curriculum. This is interesting for one fundamental reason. This is that the need to produce a science curriculum which prepares the learners for the labour market - whether the senior secondary school is the end of their education or whether they continue - was one of the rationales for restructuring the entire educational system in the country in 1976 (beginning with the Universal Primary Education project)

This is more so especially as the number of students who dropped out of the schooling system at the senior school level is far greater than those who continue. It makes sense, especially from developmental perspectives, to ensure that the science education offered to all children is capable of meeting the requirements of the labour market in some way.

And yet the analysis of the curriculum does not provide any clues to support this rationale. Clearly this rationale, recurrent in developing countries needs to be taken with caution. This is because the extent to which a science education programme should be oriented to the needs of the labour market has not been clarified in the Nigerian science curriculum. As such, it becomes difficult for both the teacher and an analyst to trace such intentions. As indicated in Table 6.1 there were no performance objectives (subsequently, no activities or topics) aimed at this orientation. What makes the caution doubly necessary is lack of clear demarcations that can be drawn, as need to be, between an educational policy statement as a political rhetoric and the educational reality of the context in which it will operate.

6.5 Section V: Analysis And Conclusions

The analysis of the curriculum emphases of the science curriculum materials in Nigeria highlights the main features of the curriculum and focused attention on its aspects which are likely to prove difficult to be interpreted in the way the curriculum developers intended. The absence of coherently developed rationale for the curriculum and imprecise and elaborate statement of general and performance objectives not only makes analysis difficult, but must inevitably result in some degree of confusion in interpretation by those teachers who use the curriculum as the basis for their teaching. Thus the major issue raised by the analysis concerns the extent to which the science curriculum presents clear specifications of intended purposes, and the methods through which it is hoped to achieve its aims.

The new Nigerian science curriculum as analysed in this chapter shares a fundamental property with most of the science curricular reforms. Like many other science curricula in developing countries, it is based on an adaptation (although the extent of the adaptation is not known), of similar science teaching and learning ideals which characterize the science curricula from the United States. Thus it also seeks to develop scientific mode of thinking in the learner through the “Science - A Process Approach” advocated by the American Association for the Advancement of Science. Its pedagogic advocacy is for learning science “through doing” and active student participation, rather than passive pedantic transfer of scientific knowledge from the teacher to the students, which, claimed the developers of the new science curriculum, characterize the way science was taught previously in Nigeria (Ivowi 1982a). Similar base rationale is also provided in other developing countries engaging in science curricular reform, such as Thailand (Sapianchai and Chewprecca 1984), Argentina (Maybury 1975), Malawi (Moss 1974), Jamaica (Commissiong 1979), Singapore (UNESCO 1976), and interestingly some developed countries such as Holland (Hondebrink 1981) and Canada (Ste-Marie 1982).

But there were different motives for engaging in the science curriculum reform in the US (or other developed countries using similar rationale) and Nigeria. In Nigeria, as in Lebanon (Za'rour and Jirmarnus 1977) India (Reay 1977), Japan (Imahori 1980), and Malaysia (UNESCO 1984), the developmental rhetoric dominated the practical realities of the educational context in which the newly adapted science curriculum is expected to operate. And it is this rhetoric which is responsible to a large extent on the problems of perceiving education as a developmental strategy.

While the needs for having a science curriculum with a different emphasis from the previous one could be justified on the basis of modernizing the science curricula, such rationales often blind the curriculum developer, but more likely, authority and power figures in developing countries to the context in which the curriculum will operate. In reality the developmental rhetoric often emerges as thinly veiled political manifesto acting as a powerful vehicle for projecting political views about social transformation, but paying little attention to operational realities. As the analysis of the Nigerian science curriculum in this chapter shows, there is nothing Nigerian about the new science curriculum. The extent to which it claims to present a Nigerian solution to developmental problems facing Nigeria have not been proved by the analysis.

The new Nigerian science curriculum shares many other properties with the general science curricula spawned by the science curriculum reform movements. But there are some areas where it stands out, either because it is still in its evolutionary form, or because its developers are still undecided about its final shape, even though it was introduced in schools all over the country from September 1985.

First, unlike most general science curriculum of the reform movements, it contains no element of choice. Schools have to adopt the new curriculum, regardless of their staffing situation or level of provisions. This is consistent with the legislative nature of entire policy of which the science curriculum is just a part. And yet it is too contentious to ignore sharp differences that exist between, say, urban and rural schools in Nigeria, which may put the latter category of schools at a disadvantage. For one, not many qualified teachers would accept posting to such schools. For another, sheer distance from the headquarters means making special arrangements for constant journeys to the Ministry of Education headquarters (normally located in the city) to request for much needed materials.

Secondly, unlike many other science curricula, the new science curriculum is not part of a course package. Beside the syllabus guidelines (or the "curriculum" as they address themselves) there was nothing else. Thus at the time the curriculum was launched, there were no textbooks to act as a medium of transmitting its philosophical beliefs, no teachers' guides or pupil worksheets. A considerable amount of uncertainty therefore must accompany the interpretation of the new curriculum.

Finally, again unlike most other curricula, there is no monitoring mechanism to determine when outcome matches expectation. But even in this, a considerable amount of confusion could be created. For instance, one of the objectives of the science curriculum is making students acquire scientific skills (as reflected in many performance objectives). But how can it be determined when someone has acquired such skills? A tempting way of finding out is through examinations. If this is the case, then it would seem the new science curriculum would come up with quite a revolutionary examination system which will test more than factual recall. Yet there were no indications this will be so. Even the standard examination does not feature much in the curriculum.

Taking these observations into consideration, it is not surprising there appeared to be a lack of precision in the determination of intentions and purposes in the new science curriculum. For instance, the analysis, besides encountering urgings to using "local examples" did not reveal any distinctive Nigerian flavour in science education. It does seem possible the curriculum, as designed is capable of being used directly anywhere.

The views of the role of science in the Nigerian society as given in the aim of the entire programme are such an an impression is created of a logical continuum between the school and the society through science education. Nowhere are considerations given to the different level of demands and expectations the school and the community outside the school make on the child. And while the new curriculum may set out to balance these categories of demands, to ignore such "two cultures" conflict indicates a lack of awareness of the possible problems of learning science in a country such as Nigeria; and this will hamper any search for a solution because it is not believed a problem exists.

But the most significant finding of the analysis is the marked lack of attention of the science curriculum to the science-society interactions. Not only is this contrary to the aims of the three science subjects stated, it is also against the general rationale of the science programme.

My analysis of the curriculum is based on it being a list of intentions, and I have illustrated certain points about its classroom implications on one or two occasions. My next focus will now be on how teachers in the specialist Science Schools, and conventional nonscience schools translate its pedagogic objectives into classroom realities, and the institutional arrangements made to enable this. This provides an opportunity to combine the analyses of the characteristics of both the science curriculum and the Science Schools in reality.

Chapter 7

Science Teaching In Kano State Science Schools

7.0 Introduction

This Chapter analyses the classroom context of teaching science in the Science Secondary Schools of Kano State. The purpose is to establish how science teaching and learning take place. Such analysis enables a close investigation of the characteristics of this science education innovation.

The focus of the analysis is to seek an answer to this research question: How are science subjects taught in the Science Schools? From this central research question, sub-questions that provide the framework for the structure of the analysis are identified. These are: what is the institutional context of teaching and learning science in the Science Schools? What are the science teaching styles and strategies adopted by the teachers in the schools? What are the students perception of teaching in the schools? What are the learning strategies adopted by the students?

The chapter is divided into five sections. Section I describes the general structure of schooling in Kano which provides a framework to understanding the operationalization of the Science Schools. Section II investigates the institutional context of the Science Schools in Kano. Section III is an analysis of the classroom dynamics of the Science Schools while Section IV offers a very limited comparative analysis in teaching and learning dynamics between the Science and nonscience Schools. Section V analyses the findings of the chapter against the theoretical background of general educational change strategies.

7.1 Section I: General Structure of Schooling in Kano State

Like in the rest of the Nigerian Federation, secondary schools in Kano are structured around a system based on the recommendations of a newly implemented (September 1982) policy on education which generally advocates 6 years for primary schools and six years for secondary schools (instead of the previous five).

Interestingly, while in the 1960s and the late 1970s the Kano State government faced difficulties in getting school age children to attend government organized schools at all primary and post-primary schools (see Chapter 4), in the 1980s one of the greatest problems facing educational planning in Kano is student overpopulation.[12]

While the number of the students in Kano seeking admission in all categories of schools has greatly increased over the years, the expansion of educational provision during the same period has not reflected the surge in demand. This situation is inevitably attributed to the ailing Nigerian economy brought about,

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[12]. Or what a former Kano State Commissioner of Education called "dramatic expansion". Speaking at a Meeting of the National Implementation Committee of the New National Policy on Education in 1986, he revealed that "In 1969 there were 241 primary schools...with 49,586 pupils. Also there were 16 post primary institutions with a student population of 4,099. Today...Kano State has over 3,100 primary schools and an enrollment of over 800,000 pupils. There are presently 220 post primary schools with over 110,000 students." (Kano State 1986).

partly, by the oil glut in the early 1980s, especially as the Nigerian economy depends on oil sales. For this reason, from May 1982 when the all the secondary schools in Kano were de-boarded, all primary and post-primary schools in Kano operate a two shift rotating system: morning and afternoon.

Under this arrangement, the distinction between Junior and Senior secondary schools is not always necessarily physical. In many cases, the senior school students (SS1, SS2, and SS3) attend school in the morning (8.00 am to 1.40 pm Mondays to Thursdays, and to 1.00 pm on Fridays), while in the afternoon (2.00 pm to 5.50 pm Mondays to Thursdays, and until 1.00 pm on Saturdays), the same school is taken over by the Junior secondary school students (Forms 1 to 3). In essence, therefore, each Senior Secondary School in Kano operates as two different schools - using the same facilities.

Because of this planning arrangement, it has not been possible for the Kano State government to maintain many boarding schools in the State. The only categories of schools exempted from this structure in Kano are the girls schools, institutions providing technical education, and the Science Secondary Schools. Thus any subsequent analysis of the schooling system in Kano State must therefore take into consideration this differential structure in planning that exists between the Science and the nonscience schools.

Clearly this arrangement could not enable the nonscience schools to provide the same range of educational services as in the Science Schools. For instance, in the boarding schools (and especially in the Science Schools), students are often provided with extra instruction after the conventional school hours, normally in two stages: late afternoon (4.00 pm to 5.15 pm), and night (7.00 pm to 9.00 pm). In the late afternoon stage, the teachers often come back to the classes and teach students, or supervise assignments. In the night stage, the school authorities provide strict observation of rules which ensure students are in the classes either completing their assignments or engaged in other academic activities.

This arrangement is not possible in the nonscience schools since the students in these schools (especially the Seniors) have to vacate the schools at 1.40 pm to make way for the Juniors. This, according to some teachers in the nonscience schools, has effects on the science students in that in the absence of any form of rigid supervision (and most homes cannot help much), students do not do much academic work outside the conventional school hours.

This dimension of difference between the Science and the nonscience schools further emphasizes the singular investment and special status of the former by the Kano State government, and will contribute towards a more effective understanding of how different from the conventional schooling structure the Science Schools are.

7.2 Section II: The Institutional Context of Science Education in the Science Schools

7.2.1 The Project in the 1980s

By mid to late 1980s, the tempo of the Science Secondary Schools Project in Kano State seemed to have slowed down since the establishment of the schools in September 1977. There are two direct reasons for this.

First, the liberalism of the Kano State Government in encouraging educational innovations whose outcomes included the establishment of Science Schools in the mid 1970s was dependent on an economic buoyancy which made such strategies easily affordable. But by 1982 the Nigerian economy has taken a sharp downward plunge due to various reasons, and this severely restricted government expenditure in all sectors, including education.

Secondly, the political advantages of the Science Schools became apparent to Kano State educational planners less than five years after their establishment. Despite initial consistent opposition among some sections of the Kano State Civil Service, two more were created after 1980, with the possibility of two more before 1990. This was a development not envisaged by the original planners of the Science Schools who based their strategy of having two to three Science Schools on the belief that the smaller the number of the schools, the higher the quality of services that can be provided and maintained in them. As the second Executive Secretary of the Board, Mallam D S Ibrahim explained,

> "I think four Science Schools will be enough for Kano for the next ten years. You see when you plan these things you have to plan it well. You have to put your investment in one or two; in any case the funds are not there. I am sure if we had started with four or six schools, the whole story would have been a failure today." (Interview 29/9/1986)

The combined effects of the increase in the number of the Science Schools and the turbulence of the Nigerian economy are seen in the clearly marked differences in both physical facilities and supply of equipments and provisions between the two older science schools (Dawakin Kudu and Dawakin Tofa, 1977), - both for boys and the Taura Girls Science School (1981, but in transit at another school until 1984) and the third boys Science School in Kafin Hausa (1985).

The two older science schools are well designed with attractive buildings located in pleasant rural pastureland, and interestingly, each located exactly 32 kilometres from Kano municipal (see frontispiece map of Kano showing the location of the Science Schools). This location is quite important, because as the Dr Ibrahim Ayagi, one of the policy initiators of the project explained,

> "(In choosing Dawakin Kudu and Dawakin Tofa), there was the consideration that the schools should be outside Kano - but not too far. I mean for the simple reason that if you place them too far from the centre, then you'd have problems with the expatriates because we knew there would be expatriates. Even the Nigerians don't like going far; so to get the best staff you should have something close by Kano where they can easily come to town." (Interview 7/1/1987)

In the newer Science Schools, which evolved in a radically different economic climate from the pioneer schools, the situation is quite different. To begin with, each one of them is over an hours' drive from Kano, and the distance alone was responsible for many teachers refusing to accept posting to the newer schools, and this, not surprisingly affects the two schools in that they are perpetually short of teachers in some disciplines. Kafin Hausa on its own is daunting because of its location (185 kilometres from Kano) and general inaccessibility by public transport. With a student population of 352 in 1987, it also needed four extra Physics (2), Chemistry (1) and Maths (1) teachers in addition to the five it already has in these subjects (Science Board figures, 1987).

The girls Science Schools was quite easily accessible, but still far from Kano according to some teachers (93 kilometres from Kano). And during my field work, there was only one Physics teacher in the entire school for over a term. Like K/Hausa, with a student population of 405, the school needed six extra teachers, one each for Biology, Chemistry, Physics, Mathematics, English and Geography. These were required to supplement the thirteen the school has in these subjects.

Again the combined effects of of economic factors as well as inadequate planning for expansion has greater affects on the newer schools in terms of their basic equipment and materials supplies. In Taura, for instance, there was no functional Biology laboratory for well over two years since the school was opened on 14th January 1985; all Biology practicals during this period were conducted in the Chemistry laboratory. This problem was acknowledged by the school authorities in an address to the Science Board Members during their familiarization tour to the school on 26th February 1985 where the Principal pleaded,

> "The provision of well equipped laboratories in a Science institution cannot be over emphasized though it is costly. At present we have two laboratory buildings finished (Chemistry and Physics), and two others at standstill (including Biology). We put our request to the Board to accelerate equipping our labs to enable us start practical lessons. Over the last six weeks, we concentrated effort in giving the students theoretical knowledge. It is therefore high time to start some practical lessons to go along."

It is thus surprising a new Science School was started without all the facilities necessary to provide its basic needs. Therefore the level of attention afforded by the Kano State government to the older Science Schools must be seen as their legacy as political strategies of the Kano State government in 1977. Since the newer science schools, and especially the girls Science School, have evolved in a radically different political and economic climates (1981-1985), they were not similarly catered for.

A typical example of this situation was illustrated during a lesson observed in the Girls Science School on Waves when the teacher had to draw a sonometer on the board, because there was none in the school and, as the teacher explained, none of the students has ever seen one. The lesson was conducted through the use of circus experiments. A fork from the kitchen served as a crude, but workable tuning fork (a tuning fork also was not available), a string tied to a stick (bow fashion), an old tin of a chocolate drink and a pair of pliers (struck on the tin) helped to convey the concept of sound propagation during the lesson (Diary 26/1/87)

7.2.2 Ability Banding in the Science Schools

One of the more explicit characteristics of the Science Schools project was its emphasis on getting high ability student population into the schools. The selection examination sets out to do just that. As the Executive Secretary explained,

> "What this exam tries to do is to fish out those who are gifted or at least those who are inclined towards the sciences. And when you bring these kids into the Science Schools, you are going to give them something much better than they had in their own schools. We select the students based on their abilities because I mean somebody who is not gifted in the sciences, if you keep him for twenty years he will never be gifted; you are just wasting your money." (Interview 23/9/1986)

It is therefore interesting despite this view, students in the Science Schools were banded according to ability. However, this was considered necessary (moreover, ability banding is the educational norm in Kano) because as the teachers of the schools explained, the diversity of the cohort schools providing students for the Science Schools means quite a few schools were not in a position to provide the students with the full range of instruction necessary to enable their students to cope with the demands of the Science Schools, if the students were eventually admitted there.

This is indicated in a decision of the Board to introduce remedial programmes for academically weak students of the Science Schools in their first year, especially those who came from the newly introduced Junior Secondary Schools. The recommendations were made by the Academic Committee of the Science Board and recorded in the Minutes of the 28th Meeting of the Board held on 20th November 1985 (Board Paper No 28/4). The recommendations, which were accepted and implemented, suggested:

> "The pioneer students (who came in September, 1985) of the New policy on education (6-3-3-4 system) may encounter some difficulties initially especially as majority of have portrayed some deficiency in English Language and Mathematics in the entrance examinations into the Science Secondary Schools. There is need therefore to organize a remedial programme that will improve the standards of those students at the initial stage. The Academic Committee has recommended the following arrangement for the First Term of the First Year of the course (in the Science Schools): English and Further Mathematics 10 periods per week each; Biology, Chemistry, Physics and Geography, 4 periods per week each; I.R.K, Agricultural Science, Home Economics and Technical Drawing, 2 periods per week each. There will be altogether 42 periods per week."

But it is curious the Board should go through this elaborate procedures when in every instance, the exacting and demanding nature of the entrance examination to the Science Schools was stressed; and also when it was made clear repeatedly only "the best" of those who took and pass the examinations are eventually chosen. As a Principal of the Science School emphasized,

> "Students to this school are chosen strictly on merit - after sitting for an entrance examination, he passes and is brought here on the basis of merit; his performance in the examination. We are involved in the selection procedure to ensure that the quality of our standards is maintained, that is, we choose the best students for our schools. Since our students are selected on merit, we expect that they will be good enough academically. They can be able to learn in a competitive situation like ours and in a very demanding situation too. We expect it in all our students." (Interview 8/11/1986)

Thus rhetoric about the Science Schools drawing their cohort among students with the most aptitude for science must be taken with caution in the analysis of the outcomes of the Science Schools project. This situation in the Science Schools also underscores the need for a more effective investigation into the quality of schooling in Kano, especially in the Primary schools.

7.2.3 Teaching Arrangements in the Science Schools

Teachers are subject specific in the Science Schools. This was more usual in the older schools, where it was uncommon for a teacher to be assigned to teach any subject beside the one s/he specialized in. But this was only possible because the individual schools ensured they received adequate teachers. This is more so in order to maintain their services to the level expected of them, more especially as any reference to the Science Schools Project in Kano was made mainly to the older schools. Table 7.1 shows the number of the teachers and the students in the Science Schools in January 1987.

Table 7.1: Teaching Staff and Strength in Kano State Science Schools, January 1987

School	Students	Teachers	Ratio
D/Kudu	702	40	1:17
D/Tofa	619	40	1:15
Taura	405	19	1:21
K/Hausa	352	22	1:16
Total	**2078**	**121**	**1:17**

The ratio given above reflects the maintenance of a consistent expectation of the student and teacher ratio in the Science Schools since their inception in September 1977. As envisaged by the Board in an internal communication written in March 1977,

> "The Secondary School of Science is expected to have 720 students when it is operating fully. Based on the new Federal Government structure of education, this will mean having 240 students per year (Forms 4-6). Whereas for the present time it will be forms 3-5. The proposal is based on 1 teacher per 20 students."

The figures in Table 7.1 did not provide the actual numbers of science teachers, for which there were quite a few vacancies. For instance, according to further figures given by the Science Board, in January 1987 there were 12 science teacher vacancies (Biology, Chemistry, Physics and Mathematics) in all the four Science Schools.

The Science Board does not seem to have an internal policy about the number of periods to be spent teaching each subject. However, in the Minutes of a Board Meeting held on 28th November 1985, the Board using the framework of the national policy on education, recommended all the Science Schools should teach Biology, Chemistry and Physics for 5 periods a week each. Since each period in the Science Schools lasts for 40 minutes this means a total of 600 minutes or ten hours for the three subjects per week. English, Mathematics and Further Mathematics were to be allocated six periods each (total of 720 minutes or 12 hours), while Geography is given 4 periods. Thus the main subjects in the Science Schools (Biology, Chemistry, Physics, Mathematics, Further Mathematics and English) occupy 1320 minutes or 22 school hours per week.

Other subjects offered to the students are Hausa and Islamic Religious Knowledge (3 periods a week each). In addition, three electives out of which a student must make a choice of one are offered; a choice of either Technical Drawing or Agricultural Science (5 periods per week each) only to the boys, and Food and Nutrition (5 periods a week) only to the girls.

7.3 Section III: Teaching and Learning Science in Kano State Science Schools

7.3.1 Teaching Strategies

In attempting to gain more understanding of how all these factors affect science teaching and learning in the Science Schools, as well as gain insights into the mechanism of the processes, one of the analytical strategies of this research was a series of classroom observations of teaching in Biology and Physics lessons in two of the Science Schools (boys school D/Tofa and girls school Taura). Part of the result of this observation is summarized in Table 7.2, and records the teaching emphases of seven Biology and Physics teachers in the Science Schools. Appendix 2 provides full and further information on the number of teachers observed per each subject and how the observations were carried out and analysed.

Table 7.2: Teaching Biology and Physics in Science Schools by Frequency of Observation and Time Spent

	Number of 5 Minute Durations Per Category					
Category	**Biol.**	**%**	**Phy**	**%**	**Total**	**%**
1. Settling Down	15	14.1	16	10.0	31	11.7
2. Teacher Talks and						
introduces topic	12	11.3	13	8.1	25	9.4
reviews topic	7	6.6	14	8.7	21	7.9
expands explana tion of topic	86	81.1	103	64.3	189	71.5
3. Students ask questions	1	0.9	0	0.0	1	0.3
4. Teacher ask questions	6	5.6	7	4.3	13	4.9
5. Teacher refers to text	0	0.0	0	0.0	0	0.0
6. Teacher writes on board for students	21	19.8	16	10.0	37	14.0
to copy						
7. Teacher demonstrates activity	0	0.0	5	3.1	5	1.8
8. Students carry out activity	0	0.0	5	3.1	5	1.8
9. Class discussion of activity	0	0.0	0	0.0	0	0.0
Total Number Of Periods	7		10		17	
Observation Time (Mins)	**520**		**800**		**1320**	

It is interesting to note the teachers emphasis during science teaching reflects the reality of the Nigerian science curriculum, rather than its rhetoric. For instance, in the introduction to the Biology curriculum, it was urged by its developers

> "In accordance with the stated objectives, the contents and context of the syllabus places emphasis on field studies, guided-discovery, laboratory technique and skills, coupled with conceptual thinking. So teachers are strongly encouraged to employ the student-activity based on an inquiry mode of teaching." (NERC 1985a p.ii)

But an analysis of the curriculum (see Chapter 6) reveals of the 754 individually stated performance objective in Biology, Chemistry and Physics, 682 or 90% belong to the cognitive domain, while the remaining 70 are psychomotor. None were in the affective. Similarly, of the 316 cognitive objectives of Biology, 203 or 65% were knowledge based, 104 or 32% aimed at comprehension, while only 9 or 2.8% were aimed at application. In Physics, 92 performance objectives out of a total 203 (45%) aimed at knowledge, 91 (44%) comprehension and 20 (9.8%) application.

Thus with a predominant internal, albeit unintended, emphasis on knowledge domain in the science curriculum, it is not surprising, despite the curricular rhetoric teachers spend over 81.1% of Biology teaching in predominantly verbal exposition and over 64.3% in Physics as indicated in Table 7.2. This is similar to the findings of Lewin (1981, 1984b) of science teaching in Malaysia and Sri Lanka who observed,

> "Less than 16 per cent of the classtime was spent with pupils actually undertaking experimentation as the main activity. Most classtime - over 32 per cent - was spent with the teacher addressing the class as a

whole...Thus considerable time was spent in class discussions introducing new information and concepts, and the greatest single number of observations occurred when teachers were requiring pupils to recall such information. Further analysis of the observation data indicated that the 'guided discovery' approach recommended in course materials was used by very few teachers. For example, on no occasion were pupils observed contributing to the design of experiments, and they were rarely asked to hypothesise, predict, interpret or infer." (Lewin 1984b p.140)

From both the strategic emphasis of the teachers during the lessons in the Science Schools, and the opinions expressed, it was clear not all teachers share the same pedagogical views of science teaching objectives as those of the developers of the new science curriculum. As one teacher expressed,

> "They are not realistic, because if you follow the set down objectives, as far as the new science curriculum is concerned, you find that it is too demanding, too demanding. It is demanding on the teacher, and even demanding on the people concerned - people who set the objectives! Surely if they are asked to bring all the necessary things which will help in achieving the objectives, I know they cannot do it. You see so many demonstrations which you need to do, but when look around you can't find what to demonstrate with." (Interview 25/2/1987)

Interestingly, the Science Schools project started out with specific views which suggested definite pedagogic guidelines for the teachers in the Schools. For instance, in an internal communication dated 25 March 1977, the Science Board noted

> "Since the appointment of the Science Board, discussions have been going on on the need to equip the Science Secondary Schools with up-to-date instructional materials/equipment whenever they (schools) are officially opened. The educational/pedagogical reason for this is simple. In order to lay solid foundations, conscious efforts must be made to ensure that both the teaching techniques and the learning styles applied are relevant and result-oriented. Once course contents take cognizance of interest/relevance/meaning and use of instructional technology, results are bound to be improved positively and speedily."

But no specific guidelines given by the Board about the sort of "conscious efforts" made to ensure teaching in the Science Schools would be consistent with these expectations. Indeed the Science Board itself was none too clear on the specifics of the pedagogical emphases of the Science Schools Project, and therefore was not convinced recommending any teaching style to its teachers would have been useful. As the Executive Secretary of the Board argued, there would be problems

> "...if you recommend a particular technique (of teaching science to the teachers). It may not be known to the teachers. You have to realize that in Nigeria today, it is not all teachers who are in the classroom who are actually teachers. They don't even have the basic qualification for teachers. They just wear degrees, you know, up and down; but they are not professionally trained teachers. Now if you tell him to adopt a

particular technique or strategy, how does he do it? Now this is something totally unknown to him." (Interview 23/9/1986)

Thus the development of educational policies in Nigeria is often characterized by a considerable lack of correlation in the relationship between policy expectation and achievement. Even in a small sub-unit of the system such as the Science Schools Project which has a certain degree of freedom in the strategies it adopts for its implementation, this seems to be true. This has significant consequences for implementation, as well as attainment of outcomes in the sense that major parts of the policy rationale behind such change strategies were not incorporated in the methods of the implementation mechanism. It is therefore difficult to determine if outcome is consistent with rationale for setting up the project, at least from teaching perspectives.

And even if some form of classroom strategies were advocated by the Board to the teachers which attempts to seek a correlation between teaching science in the schools and the overall objectives of setting up the schools (such as emphasis on labour market orientation of the teaching process in the schools), it is evident some teachers may not welcome such overtures. For instance, one teacher described for me a typical lesson which he carefully narrated to incorporate all the classic features of scientific training which the teacher believes a student should acquire. When asked what prevented him or the school authorities from ensuring every lesson was taught that way if it evoked the students' interest from his account, he explained,

> "It means trying to enforce teachers to do the lesson in that way. But you see, people who reason always work more under free atmosphere...and they (work) more effectively. But when it comes to some amount of compulsion, then they tend to feel reluctant to do the thing. So I feel the school is not doing bad by not enforcing every lesson to be conducted that way." (Interview 25/2/1987)

Thus the implementation of the ideals of the Science Schools project is further characterized by a considerable uncertainty regarding the pedagogic mechanism of attaining the objectives of the project. And left without any monitoring mechanism that ensures correlation between policy rationale and classroom practice, interpretation of the science curriculum in the Science School became subject to individual teachers' perception of teaching science. As a teacher explained,

> "In every lesson I try to sit down and write some certain objectives. Whenever I come to a lesson I try as much as possible to achieve the objectives or aim of the lesson. But then sometimes you find that I don't become successful. Setting up of objectives is okay, but it is not necessary that you achieve the objectives." (Interview 25/2/1987)

This has serious consequences for the Science Schools in that if, as was the case, the Science Board relies on the science curriculum to enable the schools to attain their objectives then teachers of the Science Schools do not express much competence in handling the new science curriculum during their teaching to enable them to achieve the goals expected by the curriculum, and by default, the policy initiators of the Science Schools. There were a few examples during the classroom processes where teachers lack of correlation between science curriculum and its teaching mode manifest themselves.

For instance, in a lesson on Photosynthesis in the boys Science School, the teacher spent about five minutes drawing a leaf and labelling it; while just a few feet from his window was a large mango tree with lush green leaves, some of which were actually swaying into the classroom. Yet throughout the 80 minutes the lesson lasted, no reference was made to this natural resource (Diary 29/10/86)

In other incidences it would appear the facilities, no matter how simple were not always used effectively by some of the teachers. In a lesson on the Human Reproductive System, the teacher spent about 10 minutes drawing and carefully labelling the various parts of the reproductive system. It was only later when he was going around the class to inspect the students' work that he realized there was a commercially prepared chart hanging adjacent to his desk. He sheepishly told the students: "by the way, for those of you who want to see further details, there is the chart on the wall." (Diary 22/10/1986)

7.3.2 Learning Strategies

A possible outcome of the teacher dominated behaviour as suggested by Table 7.2 could be a strong teacher reliance by the students. The extent to which this is so is indicated by Table 7.3 which shows the responses of the students to an item which asks them to indicate what they do if they do not understand any part of their lessons. The statistical treatment of this item is via the mult-response facility, and since the item allows more than one choice for the respondents, the percents and totals are based on the responses to each option within the item. The number of respondents to this item was 294 (out of 300).

Table 7.3 : Learning Strategies Among Science School Students (N=294)
"If You Don't Understand A Lesson,Do You Ask…."

Category	**No**	**%**
Teacher	266	54.3
Friend	125	25.5
Look It Up	77	15.7
Parents	7	1.4
Someone Else	15	3.1
Total Responses	490	100.0

(Percents and totals based on responses)

With over 70% of the teaching time dominated by the teacher (Table 7.2), it is perhaps not surprising 54.3% of the students' responses expect the teacher to explain every aspect of their lesson (Table 7.3). And asking a friend (25.5%) has higher responses than looking it up (15.7%)

The predominance of teacher behaviour as well as the students' corresponding reliance on the teacher reflected in Tables 7.2 and 7.3 respectively in schools such as the Science Schools therefore cast doubts on any science curricular advocacy that invests more learning independence on the students as in the new science curriculum.

It is interesting 15.7% of the responses are in the "look it up yourself" category which is less than the responses for "asking a friend" (25.5%). From my field work observations, such low response from a group of expectedly highly motivated students, could be attributed to the quite poor library facilities that existed in the schools I observed. During my field work, for instance, the library books of the girls Science School were in the Vice-Principal's office, because the school's library was not yet ready. As such it is not surprising few responses indicated a desire to actively search for information; the facilities by which they could so are either not available or insufficient.

7.3.3 Perceptions of Teaching Strategies

But although Table 7.3 suggests a high reliance on teachers by students in the Science Schools for advice, nevertheless the students views about what their general lessons should emphasize is at variance with their teachers' teaching emphasis. This is reflected in Table 7.4 which presents the results of the students responses to an item which asks them to indicate their views as to whether a good science teacher should make them do many experiments.

***Table 7.4: Science School Students' (N=284) Response To The Item** "A Good Science Teacher Makes You Do Lots of Experiments"*

Responses	Freq.	%	Cum %
StronglyAgree	126	42.0	44.4
Agree	129	43.0	45.4
NotSure	17	5.7	6.0
Disagree	9	3.0	3.2
StronglyDisagree	3	1.0	1.1
MissingCases	16	5.3	0.0
Total	**300**	**100.0**	**100.0**

From Table 7.4, it appears a total of 89.8% of the students agreed their teachers should make them do lots of experiments, a tendency which is at variance with the 1.8% of the time spend in doing experiments in the Science Schools (Table 7.2).

The relatively few instances where students are actually involved in experiments could not have been enough to expose them to full range of potentialities of a practical work in science at least as probably intended by the ethos of the Science Schools project. And even in those instances the feeling generated for the observer was more of a routine task than a deliberate process designed to enhance a specific mode of scientific thinking. This is illustrated by one practical I observed in the boys Science School

Teacher comes to the laboratory about five minutes late. Spends another twenty five giving a theoretical preview of the practical. The practical had two stated aims: to study the effect of heat and to see the difference between heat value and temperature. Since the experiment involved heating, one of the equipments is a wire gauze.

The group to which I attached myself (four students, each with a different "assignment" - their arrangement, not the teachers' - concerning observation and recording of the experiment) had a faulty wire gauze which actually catches fire in parts whenever it was placed over the bunsen burner, and the group leader reported this to the teacher. But no replacement could be found and the teacher told the group to “manage” with the one it had. This it did, and got a far different results from those obtained in other groups. At the end of the practical students gathered their books and left. Interestingly, the teacher did not point to the significance of this situation to the students in our group as a background to scientific technique, and when I pointed this potential source later, he replied there was no time to go into that. (Observation Notes 26/1/1987)

From this, and other observed lessons, it would appear the messages about, or the curricular emphases in, the new science curriculum, important as they are to the educational planner do not emerge as points of particular emphasis during the teaching of Biology and Physics in the Science Schools.

Moreover, those who planned the Science Schools Project did not consider the relationship between some of the dimensions of the outcome of the project (such as, for instance, emphasis on intellectual development of the students through active involvement in the scientific processes), and the impact of the curricular messages on the students during learning interactions, at least in the way envisaged by the major thrust of the science curriculum reform rationalizations. As Dr Ibrahim Ayagi, the policy initiator of the Science Schools project explained,

> “The idea of a new science was not in anybody’s mind. The idea of being dissatisfied with the science at that time or with the teaching that science at that time was not in anybody’s mind. Not as a concept. Okay may be there were deficiencies in the teaching method. May be. So the only way out is to get excellent teachers, get excellent equipment. We had no quarrel with the equipment as we didn’t even know the equipment. We knew there were equipments and there was the syllabus and so on. We knew they were there. But we didn’t bother ourselves to even look at them because we were not experts. Our expertise was only in provisions. See a deficiency and see what you to provide to overcome that deficiency.” (Interview 7/1/1987)

And yet the relatively little amount of student practical activity during teaching (1.8% as suggested in Table 7.2) is explained by insufficiency of materials and equipments which necessitates some regulation in both the frequency of the practicals and mass student participation in them. However, impressions were projected by officials this was not the case. As the Principal in one of the Science Schools explained,

> “I must say without boasting or pride that we are well equipped and well stocked with all the basic materials needed in the laboratories, and we conduct experiments regularly because we have the materials.” (Interview 8/10/1986)

But during various discussions with the teachers of the Science Schools differing views started to emerge about the sufficiency of the laboratory materials in Science Schools which were reinforced by the classroom observations. One teacher summarized the comments made by his colleagues about the laboratory situation in the Science Schools by explaining due to insufficiency of laboratory materials,

> "Last year (1986) we had to compel students to answer certain questions in the GCE Physics practical, which was unfair. But this is because the apparatus for each question were not sufficient if it were to go around. So with regards to this, I can say we are poorly equipped and I feel that the higher authorities are not serious about equipping the labs. They are more interested in the economical aspect of everything." (Interview 25/2/1987)

The emergence of lack of laboratory materials as a hindering factor to effective teaching in the Science Schools must come as a surprise considering the rationale of the entire Science Schools Project, and the investment of the Kano State Government in it. Moreover, there was evidence this was a long standing issue. For instance, during a familiarization tour of all the Science Schools which finished on 12th March 1985, a newly inaugurated Science Board visited all the schools under the Science and Technical Schools Board during which

> "Complaints were made to the Board in all schools visited on inadequate allocation of funds made to schools for purchase of instructional materials necessary for quality teaching and learning. The allocations made to the Schools on teaching equipment were far too inadequate as against actual requirement." (Minutes of the Board 17/4/1985)

Further, lack of materials, indeed, has been quoted as one of the most debilitating constraints in the Science Schools. In listing constraints to their normal functions, the authorities in one of the schools stated,

> "First among these is the financial constraints which affect the progress of the school. It is becoming increasingly difficult to replace chemicals (and) apparatus..We take what is made available for our minimum use and so we are forced to perform within the means available." (CTV documents 26/1/1986)

Thus faced with this situation of lack of sufficient materials and equipments for full practicals or actual involvement of students in an activity mode of learning, largely theoretical expositions of what could have been a practical event involving either all the students, or at least the teacher in some demonstration became the established routine of teaching both Biology and Physics.

7.3.4 Perceptions of Experiments

Despite the generally affirmative responses of the students to the item that "a good teacher should make you do lots of experiments" (Table 7.4 where 89.8% of the respondents agreed) different pattern of responses are obtained when the students were asked whether they should be actively involved in the experimentations or to let the teacher demonstrate most of the time, as seen in Table 7.5

Table 7.5**: **Science School Students' Views to the Item**: "Demonstrations By Teacher Are Better Than Doing Experiments Myself"* ***(N=293)

Responses	Frequency	Percent	Valid %
Strongly Agree	54	18.0	18.4
Agree	68	22.7	23.2
Not Sure	39	13.0	13.3
Disagree	93	31.0	31.7
Strongly Disagree	39	13.0	13.3
Missing Cases	7	2.3	0.0
Total	**300**	**100.0**	**100.0**

Although 45% disagreed demonstrations by the teacher are better, 41% also agreed leaving a small margin of difference between those who would want a teacher to demonstrate and those who would prefer to do most of the work themselves. This could be because, as Table 7.3 suggests, 54.3% of the responses indicated reliance on the teacher to resolve difficulties - a response more than any other strategy in classroom interactions; the pattern of responses in Table 7.5 may be an extension of this reliance suggesting although experiments are desirable (certainly confirmed by Table 7.4) but probably due to school factors, such as for instance, shortages of some laboratory materials (which were confirmed by teachers), it is best generally if the teacher handles it.

7.3.5 Perceptions of Classroom variables

But although it would emerge there were problems with experimentation from the teachers' perspective in the Science Schools from various accounts, and although 41% of responses from the students agreed demonstrations by the teacher ar e better (Table 7.5), only 25.3% of the responses indicated the students find the experiments themselves difficult, as reflected by Table 7.6. Like Table 7.3, the statistical treatment of this item is via the mult-response facility, and since the item allows more than one choice for the respondents, the percents and totals are based on the responses to each option within the item.

***Table 7.6**: **Science Schools Students (N=257) Response to the Item**: "Which Parts Of Your Lessons Do You Find Difficult?"*

Category	% Count	Responses
Homework	38	14.8
Experiments	65	25.3
Lessons	10	3.9
Calculations	144	56.0
Total Responses	**257**	**100.0**

(Percents And Totals Based On Responses)

It was clear from my observations the situation where 25.3% of the responses indicated finding experiments difficult could have been improved if there were efforts by the teachers to involve teaching aids in their lessons to ease the difficulties of concept formation. This is illustrated by quite a few lessons in which after a series of complicated explanations, the teacher promises a full practical at a later stage. A typical lesson with this characteristic which took place entirely in the classroom reflects this:

> The topic is Effect of Heat. Teacher introduces topic by asking questions on the definition of heat.
>
> Teacher: What is heat
>
> Student: It is a form of energy
>
> Teacher: Correct, but can you explain further since there are many forms of energy? What about light?
>
> Student: (getting uncomfortable) It stimulates vision
>
> Teacher: (to another student) What is the effect of heat?
>
> Student: Produces feeling of hotness or coldness
>
> Teacher: What about substances like rubber. Do they increase or decrease with heating?
>
> Student: Decrease
>
> Teacher: Actually it does not decrease in size, but change shape. But we will consider that when we come to the side-effects of heat in the experiment. If you are vigilant you will see that the rubber does not melt. But I am saying its size must increase before melting. If you do the experiment you will find an increase in volume so do not say it contracts.
>
> (Diary 30/10/86)

This lesson was conducted without any specific aid which will communicate the concept much clearer, although at a later stage, the experiment was done in the laboratory with the students. The adopted style of teaching in the Science Schools is always rationalized by the teachers by reference to the inadequacy of laboratory materials and equipment. As a teacher observes,

> "The two labs are fairly equipped when compared to other (nonscience) schools. But when it comes to the real consideration of whether a lab is equipped or not, I have to say that they are badly equipped, or perhaps poorly equipped. You find that if it is the day-to-day running of the teaching courses, then you can do with the few apparatus, and you can call the students around and you demonstrate something and you are okay. But when it comes to the GCE exams where you need every student to have an apparatus to himself, that is where you find the problems: that is when you find that the lab is so poor in terms of apparatus." (Interview 25/2/1987)

And yet even cases where the teacher could pick out something and call the students around and demonstrate, are not seen as common strategies of communicating more complex concepts to students. A lesson on how to construct a thermometer, also conducted entirely in the classroom and without any teaching aid (except the board), further illustrates this

Teacher gives a rather confusing detail on how to construct a thermometer. From his explanations, it was clear this is a discussion more suited to either the laboratory or a workshop. Construction details were given, but there was no single piece of equipment throughout the lesson which will help students in understanding the mechanism involved. Towards the end, a dialogue with 2 boys at the back of the class was recorded:

Student:	Sir, how an you make the numbering on the thermometer?
Teacher:	Good question! Now who knows? Who can tell us?
2nd Student:	(Gave out an explanation)
Teacher:	Good. You have a fair knowledge of Integrated Science. But we will do all this soon in the laboratory (Diary 26/1/1987)

Events such as this restrict student participation in practical activities and may partly explain why up 25.3% of the responses find experiments difficult (Table 7.6), or why up to 41% of the respondents agreed demonstrations by the teacher are better than doing experiments themselves (Table 7.5). But this does not mean the students would wish to have less experiments as part of their learning experiences as suggested by Table 7.7

Table 7.7: Science School Students' Views to the Item**: "I Think We Should Spend More Time On Experiments Than Lessons"* ***(N=294)

Responses	Frequency	Percent	Valid %
Strongly Agree	90	30.0	30.6
Agree	113	37.7	38.4
Not Sure	38	12.7	12.9
Disagree	46	15.3	15.6
Strongly Disagree	7	2.3	2.4
Missing Cases	6	2.0	0.0
Total	**300**	**100.0**	**100.0**

From Table 7.7 it emerges 69% of the respondents want more time to be spent on experiments than lessons, a pattern of response that compliments the 89.8% (Table 7.4) who agreed to the item "a good science teacher should make you do lots of experiments", even though 41% in Table 7.5 agreed demonstrations by teacher are better than doing it themselves.

But this latter response does not seem to suggest any desire by the students to have less involvement with experimentation because from Table 7.6 only 25.3% responses indicate experiments are difficult, and from Table 7.7, also only 18% respondents disagree with the item: "I think we should spend more time on experiments than lessons." But these views do not concur well with the teaching emphasis of their teachers who spend 71.1% of the classroom teaching in a non-experimental mode, spending, instead 1.8% of the time, from my observations, in actual class experiments (Table 7.2).

Thus generally students in the Science Schools would seem to express a very favourable attitude towards experimentation. This is not surprising considering the nature of the Science School. Since the special status of the project has been repeatedly emphasized by both teachers, administrators and government officials, it would have been surprising if a significant response from the students of these special schools indicate a non-interest in experimental activities - the main backbone of scientific training.

But what is not clear is whether such high positive attitude of the students is the result of the provisions of the Science Schools, or reflect the personal response of the students towards experimental work, which could remain constant regardless of whether they are in Science or conventional secondary schools, especially since the selection examination has established them as students with high aptitudes to science. It may thus be seen as a limitation of this research that it has not been possible to establish whether it is the Science School which makes students develop such attitudes. This is important since if the schools can be established as the causes of such positive attitudes, the finding would reinforce the major policy rationale of creating the schools.

What is surprising is the lack of resonance between the students seeming enthusiasm for practical experimentations and the teachers' teaching style. This is more so since the teachers, like the students, are also carefully selected. As a Principal of a Science School explained,

> "Before a teacher is employed, there may be as many as probably 100 like him who might have applied for the same job to teach in the Science Secondary School. But we end up selecting may be five or ten out of the 100 because we want the best for our schools. And having selected the best just like we do with the students, then we give them the best salary or the best payment they can get from all around. And therefore even without being told you know you are expected to do wonders because you already have in mind that you coming to a Science School and you know that these schools are special, so the expectation on you is high." (Interview 8/10/1986)

But these expectations are not matched by the teaching emphasis adopted by the teachers of the Science Schools (Table 7.2). But disparity between what the curriculum developer (or administrator) aims at, and what teachers do in the classroom, is emerging as a standard feature of science education curriculum reform, in both developing countries (Lewin 1980, 1981, 1984b; Maddock 1981b), and interestingly, in some developed countries such as Canada (Aikenhead (1984, and Ste-Marie, 1982). For instance the report of various case studies of observations of science teaching in many Canadian schools revealed,

> "Senior-year teachers view science as precise method and as a system of exact numbers highly organized bodies of information and specialized terminology. Their concern is to provide students with the notes and with the practice in solving problems that will result in high marks on examinations and allow the student to move through high school to university. work in the lab is geared towards illustrating facts and theories presented in the classroom, confirming what is discussed in class, obtaining precise facts and getting the right answers to problems...Alternative approaches, such as those emphasizing inquiry process or the relationship of science to social issues or technology, are not seen as central activities for the science classroom, but as a means of encouraging interest." (Orpwood and Souque 1984c p.23)

And as explained earlier, the initiators of the Science Schools Project themselves were none too sure of what pedagogic emphases the schools should provide for the students. Further, as the Executive Secretary explained when asked about how the Board translates its objectives.

> “Well, you see in most cases you will find that objectives you may have here may be scanty kind of objectives because if you say these are your objectives as a Chief Executive of the place then it is going to be translated by the teachers. Now these objectives are the same objectives as those of WAEC, CESAC and other bodies responsible for curriculum development. Academically we don’t interfere very much because there is a laid down procedure, schemes, syllabuses and so on for the students to cover.” (Interview 23/9/1986)

From this account, it would seem the Science Board uses the curriculum objectives as its main mechanism of achieving its objectives. This is an alliance which requires extreme caution because any deficiencies of the science curriculum forms a substantial deficiency of the Science Schools.

7.3.6 Perceptions of Mathematical Conceptualization

A further interesting finding from Table 7.6 is the 56% responses which indicate students finding calculations difficult. Such figures for rate of difficulty in calculations among Science School students must come as a surprise considering a central feature of the selection examination for the Science Schools was passing Mathematics. Failure in the subject means disqualification from the interviews and non-placement to the Science Schools. But it cannot be concluded the students find mathematics generally difficult, although finding calculations difficult may be a reflection of difficulties in mathematical conceptualization.

But from information made available by the Science Board in January 1987 concerning staff strength in the Science Schools, the situation may be explained by relative lack of Mathematics and Physics teachers (four vacancies each) in the Science Schools. These are the only subjects for which there was a much as eight vacancies in the Science Schools.

7.3.7 Perceptions of Lessons

Although there is a little resonance between the teaching emphases in Science Schools (Table 7.2) and students general expectations about experimentation (Table 7.4) nevertheless there is between the category of “expanding explanation” in Table 7.2 and Table 7.6 where only 3.9% of the responses indicated lessons as being difficult. This would seem to suggest an easier assimilation of the lessons by the students, and it could be contributed by the way the lessons were conducted in the Science Schools.

From field work observations, the lessons were far more strictly supervised by the school authorities than the practicals. The normal routine of the Principal was to go around the school observing classes that were empty. Teachers who were absent were sent queries and were made to make up for their absenteeism at a later stage. This regimentation - explained as necessary to maintain standards - lends an air of compulsion to the individual lessons, and as such possibly affects their format.

But a more structured category of supervision (i.e. making sure teachers are actually teaching) concerns individual lesson observations by the Head of Department as I noted in one Science School. Interestingly, this supervision is often guided (unlike the first one by administrative officers of the school) by an Observation Schedule. The results of the observation, according to the school authorities, were used as part of teacher assessment of competence and used as part of the criteria for consideration of promotion or renewal of contract.

The schedule used in this School has 10 dimensions all aimed at determining the quality of lesson delivery on a grade of good, average and poor. The dimensions include Lesson notes, use of black board, audibility, classroom control, student participation and overall assessment of lesson. Surprisingly, there was no dimension aimed at assessing experimental aspects of the lesson (A copy of this Schedule is included in Appendix 2).

Further, despite the Boarding facilities which makes it possible to restrict assignments to prep periods, often assignments were given to students during standard lessons which virtually take up all the time. A typical case was the following which took over forty minutes during a Biology lesson

Write briefly on the following, giving examples in each case

a) Adaptation of the Fauna to tropical rain forest
b) Adaptation of the Fauna and flora of the Savannah
c) Adaptation of the fauna to fresh-water swamp

(Diary 25/2/1987)

More time was spent while students copied the assignment and this was followed by a discussion which lasted for less than 20 minutes before the 80 minute period ended.

It is interesting to note lack of reference to any printed text material in Table 7.2. And although this gives the impression of a smooth presentation of lesson material un-hampered by the need for constant references to text books by the teacher, nevertheless there was a strong adherence by both teachers and students to information from text books. This is shown, for instance, in an exchange during a Biology lesson

Teacher:	Who can define Biomass?
Students:	Silence
Teacher:	(getting impatient) Can't anybody answer? You (points to a boy nearest to her)
Student:	Ma, the topic is not in our textbook
Teacher:	Okay we will discuss it now (28/1/1987)

The textbook becomes the ultimate guide for both the students and the teachers, no matter how inappropriate its contexts can be. In another case, in a Physics lesson on ***Sounds*** in the girls Science School, the teacher began by asking the students if they could distinguish between the quality of sounds produced by a flute, an organ and a harp. No one answered. He then referred them to musical shows on the television where musicians use, for instance, electric organs. Again there was no response from the students. The lesson continued. After the lesson I discussed with him the appropriateness of his examples to students who, in all possibility, have never seen such instruments. He replied those were the examples given in the textbooks he uses (Abbot and Nelkon. Diary 3/11/1986)

Because the textbook is heavily used examples of flora and fauna emphasized during the lessons tended to be those found mainly in them. They are cited because the textbook includes them. In a lesson on classification of animals, the following was recorded:

Teacher:	Monotromes are mammals that lay eggs. Who can give me an example?
Students:	Silence
Teacher:	(continuing almost immediately) the Duck-billed platypus. Such as what?
Students:	(in chorus) Duck-billed platypus (Observation Notes 29/10/1986)

No other examples were either asked for nor given by the teacher. And it was not entirely clear whether the students have actually encountered a *duck-billed platypus*, with the possible exception seeing a picture of it in the textbook.

Often the "local relevance" theme of science education in developing countries (as for instance, stressed by Alabi 1980; Knamiller 1984, and Maddock 1981a) does not emerge as a guide during teaching in the Science Schools. There were no references at all in any of the lessons I observed about science in the society or science in employment. Indeed science in any context was not provided to the students except as a pure straight forward school subject to be studied, and passed in examinations for the purpose of proceeding to higher education, a view well supported by the Science Board. As the Executive Secretary argued,

> "When you are training people at the secondary school level, you are not training for a career as such. I mean you are giving them a basic education for take off for post secondary level. It is only when they get to the universities or the polytechnics that they really get inclined to a particular area. We are not training anybody for anything. We are giving sound basic education. Sound basic education. That is all. So when they finish from here they go into various areas" (Interview 23/9/1986)

Further, during discussions with teachers, I brought up the issue of field trips which has been suggested as a teaching technique in the new science curriculum. As the curriculum stated,

> "In accordance with the stated objectives, the contents and context of the syllabus places emphasis on field studies, guided-discovery, laboratory technique and skills coupled with conceptual thinking." (NERC 1985a p.ii)

Some teachers admitted they have never taken students on any field trip because they do not believe they are necessary (responses of Physics teachers mainly), while others (Biology) claim they had the intentions, but the schools do not have transport to carry the students to the field trip site.

Science teaching and learning in the Science Schools therefore became a routine process aimed at producing a certain type of qualified student for admission in further education. The teaching dynamics seemed to be removed from the broad conceptualization of science education, as well as the rationale of the the project itself.

7.4 Section IV: Nonscience School Perspectives

7.4.1 Teaching Strategies

Due to the nature of deliberate and emphasized differences between the Science and the nonscience schools, it would not be possible to make fair comparative judgements concerning teaching, learning and student achievement in both the two categories of schools. Indeed the differences between the two school is the most compelling rationale for the establishment of the Science Schools project. As officially noted,

> "The acute shortage of manpower in (Kano) State was largely due to lack of right kind of educational facilities available. Teaching facilities (laboratories, equipment, teachers etc) compared against actual requirements were far too inadequate. It was against this background that the Manpower Planning Committee recommended the establishment of specialized Science Secondary Schools in the State, with the full compliment of qualified teachers and adequate facilities, to provide qualitative Science Education to carefully selected students.." (Kano State 1979c)

The purpose of this section therefore is to seek a pedagogical foundation for this rationale by briefly analysing classroom interactions in the nonscience schools in terms of teaching approaches, learning difficulties, and learning strategies to note their pattern and direction.

The first focus of this analysis is the teaching approaches used in the nonscience schools indicated in Table 7.8

Table 7.8: Teaching Biology and Physics in Nonscience Schools by Frequency of Observation and Time Spent

	Number of 5 Min Durations per Category					
Category	**Biol.**	**%**	**Phy.**	**%**	**Total**	**%**
1. Settling Down	7	10.6	7	8.5	14	9.4
2. Teacher Talks and						
introduces topic	6	9.0	6	7.5	12	8.1
reviews topic	5	7.5	2	2.4	7	4.7
expands explanation of topic	29	37.8	48	58.5	77	52.0
3. Students ask questions	3	4.5	13	15.8	16	10.8
4. Teacher ask questions	0	0	0.0	2	2.4	2
5. Teacher refers to text	0	0.0	14	17.0	14	9.4
6. Teacher writes on board for students to copy	10	15.1	8	9.7	18	12.1

7. Teacher demonstratesactivity	0	0.0	4	4.8	4	2.7
8. Students carry outactivity	0	0.0	0	0.0	0	0.0
9. Class discussion ofactivity 0	0	0.0	0	0.0	0	0.0
Total Number Of Periods	**5**		**6**		**11**	
Observation Time (Mins)	**330**		**410**		**740**	

It is quite interesting to note the similarity between patterns of teaching of both the Science (Table 7.2) and the nonscience schools (Table 7.8). Like in the former, a considerable amount of the time is spent by nonscience school teachers in "expanding the explanation of the topic" (52%). During my field observations, there was no single incidence in which students actually carried out any experiment, even though most of the lessons in the nonscience schools (especially Physics) took place in the laboratory. The only semblance of practical activity were in the few times (2.7%) when the teacher demonstrates with pieces of equipment on his table to illustrate a point. Even then, this was done only by Physics teachers.

The situation where only the teacher handles the equipment in this category of schools is attributed directly by the teachers to material constraints which does not allow the teachers to be liberal with the little they have. As a teacher complained,

> "The laboratory should be equipped for 40 students, but you see yourself every equipment is either one or two. So I divide them into groups, for example one thing for 10 boys, one apparatus for 15 students...Most of the things here (waves around the lab preparatory room) are not working. For example these voltmeters. The school buys new material only during examinations. But during normal teaching there are no materials most of the time. But when WAEC comes, then the school will buy what I request. The excuse is that the materials are very expensive." (Interview 15/2/1987)

And yet for all this, like in the Science Schools, contrary impressions are projected by school authorities concerning the sufficiency of materials for experimental work. As the Principal of the same nonscience school assured,

> "As far as (laboratory) equipments are concerned, I think we are fairly alright. This is because from the very beginning we have three established laboratories. And they are standard, and almost all the equipments are there. And we have teachers who are trying their best." (Interview 30/9/1986)

However, it should be appreciated in the nonscience schools the premises including the laboratories are used twice in a day by different sets of students. In the morning shift, the Junior Secondary School students use the same facilities for Integrated Science, an arrangement which may contribute to depletion of overall resources in the school. Nevertheless a striking similarity is found between the Science and nonscience schools in general teaching strategies - made more interesting since the former category of schools do not face this shift problem.

Moreover, despite any constraints imposed by little interaction with materials during lessons, the general view of the students regarding the ease of science as a discipline does not differ much from the Science School respondents, as Table 7.9 shows

***Table 7.9: Science Students (N=478) Responses To The Item**:*
"Science Is Easy"

	Science (N=284)		**Nonscience** (N=194)	
Response	**No.**	**%**	**No.**	**%**
Agree	189	66.5	124	63.9
Not Sure	36	12.7	24	12.4
Disagree	59	20.8	46	23.7
Total	**284**	**100.0**	**194**	**100.0**

(Chi-square = 1.783 Significance = 0.775)

Although Science School students, by the virtue of the selection exercise are expected to have a high enthusiasm for science generally, it is interesting to note the lack of significant difference (at 0.05 per cent level) between the two groups. It would seem science students in Kano State, no matter their learning circumstances can lay claims to finding science easy.

Moreover, although the selection process in the nonscience schools where students who are considered "pure" science students (basic offering of Biology, Chemistry and Physics), is less rigorous (there is no structured selection examination), nevertheless the science students in nonscience schools have greater subject choice than students of the Science Schools. The former students can combine science with liberal arts options, for instance. It is therefore interesting despite the different possible subject combinations in the nonscience schools which may impose some constraints on students (by being made to offer more subjects with less cross-conceptual linkages than in Science Schools), yet this class of respondents can also claim science is easy.

It is also interesting to note 14% of the time in the Science Schools (Table 7.2) is devoted to writing notes by the teacher, and 12.1% of the time devoted to similar task in the nonscience schools (Table 7.8). This would seem to suggest a lack of economical use of the time in the Science Schools because due to their nature (they are all Boarding schools), extra time exists in the evening or night for prep, homework and note-taking. From my observations, the need to cover the syllabus as quickly as possible seems to make some of the teachers insist on giving notes during normal school periods, using the prep period to effect more coverage by giving more notes. This would seem to be a particular tendency with Biology teachers.

But teachers in the nonscience schools rationalized giving notes is the only way of making sure some written record of the lesson exist, as the students revise only when the examination approaches. As a teacher explains,

> "Here in Kano State, both authorities and the students are interested in giving notes. This means I have to write everything on the blackboard. Although you can dictate, but you will say something and they will write another thing with lots of spelling mistakes and so on. So most of the time is taken up with writing notes. Without notes students find the lessons very difficult because they don't have the books. There is no other way than this. With too much time spent on note taking, little time is left for activities." (Interview 15/1/1987)

In the two nonscience schools observed, I noticed it was usual for more than a whole period (40 minutes) to be spent copying notes given by both the Physics and Biology teachers. Interestingly, in the Science Schools, only the Biology teachers spend a lot of time giving notes during class teaching, possibly because of the more descriptive nature of Biology as taught in Nigeria.

Another dimension of similarity in classroom dynamics between the Science and nonscience schools is lack of emphasis of local materials (i.e. the "local relevance" theme alluded to earlier) during lessons. Although the Observation Schedule used did not include category facilities for measuring this dimension, yet recordings of classroom exchanges provide a picture of the situation. The following incidence in a nonscience school during a Biology lesson is a fairly typical case

> Teacher writes **Hydra** on the board, and for the next 25 minutes delivered an eloquent lecture on the life history of *Hydra*. Its full anatomical features were expanded and carefully labelled. Teacher stops suddenly about twenty minutes later and asked if there were questions. Silence from class. Eventually he continued till the end of the lesson. Asks again if there are questions. A boy sitting next to my desk raised his hand. The following dialogue followed:
>
> Student: Sir, where is *Hydra* found?
> Teacher: (Silent. Eventually replied): I don't think you will find it here (in Nigeria) It is mainly found in Europe
>
> Another student raised his hand also:
> Student: Sir, what are its advantages and disadvantages?
> Teacher: (Looking flustered) We will be coming to that soon
> (Diary 17/11/1986)

7.4.2 Perceptions of Some Teaching Variables

Interestingly, it is not only in the area of lack of correlation between official rhetoric about the laboratory facilities and the reality are similarities found between the Science and nonscience schools. Table 7.8 reveals a pattern of teaching emphasis which is similar to Table 7.2. Such similarities are also found in some student learning variables as suggested for instance by Table 7.10. The statistical treatment of this item is via the mult-response facility, and since the item allows more than one choice for the respondents, the percents and totals are based on the responses to each option within the item.

Table 7.10: Perception of Difficulty of Science Teaching Variables Among Science Students (N=469) in Kano State

		Learning Category				
		Homework	**Experiments**	**Lessons**	**Calculations**	**Row Total**
	Count	38	65	10	144	257
Science	Row %	14.8	25.3	3.9	56.0	
	Col. %	58.5	56.0	32.3	56.0	
	Tab. %	8.1	13.9	2.1	30.7	54.8
Nonscience	Count	27	51	21	113	212
	Row %	12.7	24.1	9.9	53.3	
	Col. %	41.5	44.0	67.7	44.0	
	Tab. %	5.8	10.9	4.5	24.1	45.2
	Col. Total	**65**	**116**	**31**	**257**	**469**
	Col. %	**13.9**	**24.7**	**6.6**	**54.8**	**100.0**

(Percents and totals based on responses)

The responses in Table 7.10 suggest close similarities in most of the variables. It is interesting experiments and calculation - strong components of science teaching and learning - constitute greatest difficulty according to the responses among both the Science and nonscience students. This is more so since in Table 7.9 66.5% of the Science School students and 63.9% of the nonscience group claimed "science is easy."

While my observations, pupil questionnaires and teacher interviews have not revealed any specific clue as to why the Science School students should face problems with calculations (except may be for lack of Mathematics and Physics teachers), in the nonscience schools, teachers listed one of their own difficulties in teaching science as the poor mathematical background of the students which makes subjects such as Physics difficult to teach. In quite a few cases, teachers faced considerable difficulty in teaching topics with some amount of mathematical calculations in the nonscience schools, no matter how simple. The following incidence during a Physics lesson in one of the nonscience schools illustrates this.

> Teacher comes in and writes Relative Density on board as the topic of lesson. Begins the lesson until a calculation is reached. Stops and asks the class "What is a number divided by one?" Silence. Some students look puzzled by the question. Teacher repeats the question two more times. Eventually a boy in front of the class shouted out, rather nervously, "One!". Teacher commends the boy, and looks at me with a shrug of shoulders. Asks again, "What is difference between mass and weight?" No answer. Teacher repeats the whole routine again. But he has to give the answer himself eventually. (Diary 12/11/1986)

The incident above is typical and underscores the fundamental problems science teachers faced in conventional secondary schools in Kano. As a teacher summarized about his students,

> "I find it difficult to make them understand certain concepts, especially those requiring knowledge of mathematics. They have a very poor background of mathematics. These boys don't know the meaning of linear, direct and inverse proportionality for instance. So often we waste a whole period teaching them mathematics before we teach the main subject." (Interview 15/1/1987)

But despite any learning difficulty, students in both Science and nonscience schools do not envisage themselves as wanting less science lessons, as the responses in Table 7.11 show.

Table 7.11: Science Students (N=481) Response to the Item
"We Should Have Less Science Lessons Than We Have Now"

	Science (N=284)		Nonsci (N=197)	
Response	**No.**	**%**	**No.**	**%**
Agree	40	14.0	31	15.8
Not Sure	35	12.4	27	13.7
Disagree	209	73.6	139	70.5
Total	**284**	**100.0**	**197**	**100.0**

Chi-square = 9.283 Significance = 0.054

It is not surprising 73.6% of the Science School students disagreed to having less science lesson since they have no other subjects to study in great depth (such as liberal arts options). The high number of the nonscience school students who disagree (70.5%) is also understandable in the light of the 63.9% in Table 7.9 who claimed to find science easy.

7.4.3 Experimental Work in the Nonscience Schools

Surprisingly, as in the case of the Science Schools, only a few of the students in the nonscience schools also indicated finding experimental work difficult (24.1% of the responses in Table 7.10). Finding experimental work difficult for this set of students can be more appreciated when the nature of the schools is taken into consideration as explained previously. A typical dialogue during a Physics lesson where the teacher wanted to continue a lesson on Relative Density in a nonscience school illustrates this.

Teacher:	How do you determine the density of this chalk?
Students:	Silence. No one answered
	Teacher then started going round the class asking individually
1st Student:	By measurement
Teacher:	What do you mean? What type of measurement?
1st Student:	Silence
Teacher:	You! (pointed to the next student)
2nd Student:	Silence (This went on until the 7th student)
7th Student:	By measuring mass (answering the initial question)
Teacher:	How?
7th Student:	Silence
Teacher:	You (pointed to the 8th Student)

8th Student: With spring balance

Teacher: You cannot measure mass with spring balance!! Now who can tell me; mass is measured by what balance?

9th Student: Chemical balance

Teacher: Correct. What do you do next? (Diary 12/11/1986)

This went on until a response with some similarity to the answer was received (actually given by the boy who suggested spring balance). The teacher was annoyed at the length of time it took for the answer to be given, and berated the students for not paying attention previously.

It was quite clear this experiment was not actually done by the students, although the teacher demonstrated it to them at one stage. It was also clear students have not been used to handling laboratory equipments, even from the length of time it took for the answer to be given.

But a considerable issue raised with the teachers was, if the level at which the students can be expected to participate in the lessons as in an activity is infrequent (and during my observations - Table 7.8 - there was no incident where a single practical was carried out by the students), then what actually prevented them from having some form of organized practical for the students at least once a week? A teachers' response to this was,

> "Practicals? We have a problem there. Look, this is supposed to be a pioneer institution (established 1927). It is ill-equipped for practical experiments. There are a lot of things dumped. Parts of them are missing. They can only be used as demonstration apparatus. But only a few pieces of apparatus are there for performing actual experiments." (Interview 15/1/1987)

The frequency with which the students were allowed to interact with experimental situation in both the Science and nonscience school is attested by the the students themselves in Table 7.12

Table 7.12: Science Students (N=492) Views to the Item:
"Our Teacher Discourages From Experimenting On Our Own"

	Science (N=295)		Nonsci (N=197)	
Response	**No.**	**%**	**No.**	**%**
Agree	43	14.6	52	26.5
Not Sure	20	6.8	19	9.6
Disagree	232	78.6	126	63.9
Total	**295**	**100.0**	**197**	**100.0**

Chi-square = 15.212 Significance = 0.0027

It is interesting to note a highly significant difference between the two groups in Table 7.13. This may not, however, be attributable to their contexts because discussion so far carried out does not seem to provide clue which will generate such significant difference in the pattern of responses of the students in this variable. For instance in both the Science and nonscience schools contradictory impressions of the status of science laboratories and frequency of practicals were given by the school authorities and teachers. Also, in both the two categories of schools teachers complained of lack of materials for standard practicals.

Certainly, in the Science Schools despite only 1.8% of the time being available for participation in class experiments (Table 7.2), students are encouraged to fully engage themselves during practicals more than the nonscience school students, although with strict supervision. This may account for why 26.5% agree teachers discourage them, compared to only 14.6% who agree in the Science Schools. As a teacher in the Science School explains,

> "We can't allow students to do experiments on their own, unless that experiment has once been done by the students. But when an experiment is to be done for the first time, personally I don't allow my students to do it on their own. Even if I write the instruction on the Board, I had to explain and go around. This also serves to monitor the use of equipment because if you don't do that, they can break things." (Interview 25/2/1987)

And considering the nature of expectations surrounding the Science School, it is thus not surprising 78.6% of Science School respondents disagreed they were discouraged from experimenting on their own, as contrasted with the 63.9% of the nonscience school students with the same range of responses.

7.4.4 Learning Strategies of Science and nonscience students

The Science and nonscience students' learning strategies seem to share a remarkable similarity as suggested by 7.13. The statistical treatment of this item is via the mult-response facility, and since the item allows more than one choice for the respondents, the percents and totals are based on the responses to each option within the item.

Table 7.13: Learning Strategies Among Science Students (N=492) In Kano

		"If You Don't Understand A Lesson Do You Ask..					
		Teacher	**Friend**	**Look it up**	**Parents**	**Someone Else**	**Row Total**
	Count	266	125	77	7	15	490
Science	Row %	54.3	25.5	15.7	1.4	3.1	
	Col. %	61.3	78.6	70.6	70.0	65.2	
	Tab. %	36.2	17.0	10.5	1.0	2.0	66.7
Nonscience	Count	168	34	32	3	8	245
	Row %	68.6	13.9	13.1	1.2	3.3	
	Col. %	38.7	21.4	29.4	30.0	34.8	
	Tab. %	22.9	4.6	4.4	0.4	1.1	33.3
	Col. Total	434	159	109	10	23	735
	Col. %	59.0	21.6	14.8	1.4	3.1	100.0

Percents and totals based on responses

It is significant to note from Table 7.13 the similarity in responses between the two groups, especially in certain variables, such as teacher dependency where

54.3% of the Science School and 68.6% of the nonscience school responses indicated a strong reliance on the teacher as the first resort of resolving difficulties in learning.

Moreover, the range of differences among the row percentages in Table 7.13 yields a revealing pattern in the responses. For instance, there would seem to be less reliance on a “friend” to explain things in the nonscience schools as only 13.9% responses indicated using this strategy as contrasted with 25.5% of Science School responses. There is however a close similarity in the nonscience students responses between “friend” responses and “looking it up yourself”, the latter yielding 13.1% responses from the nonscience students.

Although both the two groups of students indicated the teacher as the main source of explanation about any aspect of their lesson, yet there is a highly significant difference in the pattern of their responses regarding whether they feel their teachers discourage them from studying science as a discipline, as indicated in Table 7.14

Table 7.14: Science Students (N=481) Response to the Item:
“Our Teachers Discourage Us From Studying Science”

	Science (N=287)		Nonsci (N=194)	
Response	**No.**	**%**	**No.**	**%**
Agree	15	5.2	25	12.8
Not Sure	11	3.8	24	12.4
Disagree	261	90.9	145	74.4
Total	**287**	**100.0**	**194**	**100.0**

Chi-square = 26.5363 Significance = 0.000

A 54.5% teacher reliance amongst the Science School students as indicated in by Table 7.13, might have been a contributory factor to the 90.9% respondents in Table 7.14 who disagreed “our science teacher discourages from studying science.”

There is a similarity with the nonscience school respondents in this variable. In this category, although 68.6% (Table 7.13) indicated referring to the teacher, about 74.4% (Table 7.14) disagreed to the variable: “our teachers discourage us from studying science.” Thus although the overall significant difference between the two groups in this variable is quite high, it is clear this was not the result of what they disagreed on, but on what they agreed on. This is because 12.8% of the nonscience school sample, and 5.2% of the Science Schools sample agreed to the item, with thus a wide margin of difference.

There would seem to be a similarity generally between the Science and nonscience schools in some teaching and learning strategies of both the teachers and the students respectively, despite their emphasized administrative differences.

Differences in attitude to experimentation and learning variables among the students may or may not be attributed to differences in the institutional context of learning science among the respondents. But there is not enough evidence for this. By the virtue of their limited nature, these findings did not yield significant confirmation of the rationale that creating the Science Schools will enhance better teaching from the teachers. But it does yield significant insights into the nature of both the Science and nonscience school students' approach to learning science, which may or may not be maintained on a wider expansion and analysis of further learning variables.

7.4.5 Aims for Science Education

From the discussions and analysis of the classroom dynamics in both the Science and nonscience schools, it was evident the fundamental thrust of teaching in both the categories of schools emphasizes school science as content. A striking characteristic of this in both the Science and the nonscience schools is my perception of marked lack of emphasis by the teachers on higher order cognitive skills as well as affective outcomes during all the science lessons I observed. For the most part lessons tend to be well presented text-book versions of the information being discussed. With regards to this observation, the teachers can be divided into two groups.

The first group are those who were not aware of these skills and their relationship to science. These were mainly found in the Science Schools, and they blamed it, apologetically, on their lack of formal educational qualifications in handling science teaching in any manner except the one they feel most comfortable with. A typical response from a teacher in a Science School which summarizes the general situation was

> "Personally for me there is this question of lack of equipment. There is also the question of lack of experience. Sometimes I lag behind as regards the rate at which I go which I know arises because of my lack of teaching experience. That is a problem." (Interview 25/2/1987)

In the Science Schools none of the science teachers observed for this research (in Biology and Physics) had any formal training in education. They were all single honours science graduates. Whether this is significant or not is difficult to confirm, since it is hard to suggest lack of formalized professional qualifications could be responsible for misinterpretation of science education objectives, although it opens avenues for further exploration.

The other group was made up of teachers who also lacked formal professional qualifications in education, but had the experiences of teaching science for many years in secondary schools, both in Nigeria and in other countries. These were mainly found in the nonscience schools. And since they are directly under the control of the Kano State Ministry of Education, membership to the Science Teachers Association of Nigeria (STAN) is compulsory, as well as attendance to all science education workshops, courses and seminars conducted by the Ministry of Education through the Kano Educational Resource Center. As the Principal of a nonscience school explained,

> "There are a lot of advantages to membership of STAN since they organize seminars to improve the teachers methods of teaching subjects. And they discuss things that are relevant to the teaching of science. The teachers therefore benefit. As a matter of fact, they pay fees and the Kano State government encourages them to join because even the annual fee is taken from the salaries and the government pays it to STAN." (Interview 15/10/1986)

Teachers from the Science Schools do not have to attend any of these seminars since the schools are not, administratively, under the Ministry of Education. Membership to STAN by these teachers is also an individual affair; and most of the teachers whom I talked to were not STAN members. However, teachers are often sent on STAN workshops by the Science Board which makes attempts also to get its teachers generally involved in as many in-service activities as possible at the discretion of the Staff Development Committee.

Thus while nonscience school teachers teachers were more exposed to longer classroom experience than teachers in the Science Schools (they were also more cynical of the expectations of the new science curriculum) nevertheless their use of the science curriculum does not differ from the former group as suggested in Tables 7.2 and 7.8

Moreover, quite a few of the teachers (in both the Science and the nonscience schools) were of the view the science curriculum as currently used in Nigeria is too advanced for the students and blame any lack of correlation between their interpretation and the curriculum on the advanced features of the curriculum. As a teacher in a nonscience school argued,

> "This syllabus is really good, but it's far too advanced for the students...It's difficult for them. Believe me it is too difficult for them, because of their poor background especially in Maths. They are very poor in Maths. Not poor, very poor." (Interview 15/2/1987)

Based on this, most of the teachers feel they face an uphill task in trying to make students understand a science course which, in their view, is too difficult for the students. Consequently, they argue, it is difficult to implement as envisaged. And this, to them, provided a rationalization for their teaching styles.

And yet in all in all cases teachers are anxious to stress to me their convictions of the desired qualities of science children should acquire. For instance, according to a teacher,

> "Science should encourage certain characteristics such as curiosity and honesty, because you find that when somebody studies science he tries to find facts, then he tries to present them as he find them. This gives training towards honesty." (Interview 25/2/1987)

This view was followed by a recitation from the teacher which illustrated this particular function of science during a recent (Physics) practical (but this view was also provided by Biology teachers). But it was evident this was a statement of what the teachers feel they should voice out as science teachers, rather than because they believe such qualities can be acquired through teaching the new science curriculum according to its objectives or through their teaching strategies. For instance, although acquisition of scientific curiousity was a commonly voiced out purpose of teaching science by the teachers, significantly in none of their lessons did I observe any tendency towards enabling students to acquire this, and related, trait. This was actually responsible for a major alteration to the Observation Schedule (see Appendix 2).

What emerged from the various discussions and interviews but mainly from the observations in the classroom is the conviction that both the teachers and the administrators of the Science Schools are unaware of the subtleties of the new science curriculum, the extent to which its objectives correlated with the objectives of setting up the Science Schools, and clearly do not perceive much difference between the old and new syllabuses in terms of content and pedagogy, but in scope.

7.5 Section V: Analysis And Conclusions

In order to gain an insight into the mechanism of the Science Schools and how they attempt to achieve the goals they were established to attain, an analysis of various classroom interactions was carried out using a structured observation schedule in Biology and Physics lessons. The incidences about the learning interactions reported during the analysis did not emerge as unique to particular cases, but clearly as general patterns of teaching and learning science in the Science Schools.

This section analyses the most sensitive segment of any change strategy: its implementation. By looking at the implementation process, the analysis enables a close examination of the characteristics of innovations in science education according to the themes of science education innovations as identified in Chapter 2. But in my analysis, I will also draw from the theoretical frameworks on the implementation of innovations as explored by Fullan (1982) who identifies four major aspects pertaining to the nature of the change strategy itself which he argued relate to subsequent implementation. These are need, clarity, complexity, and quality and practicality of the materials (product quality).

The Science Schools Project is seen as an important and far reaching social change strategy by its initiators. This same view was not shared by all its subsequent implementors. Although the Science Schools depend on a pool of well qualified science teachers to sustain their objectives, their supply has not been possible because of the waning of government enthusiasm with the project a few years after it has started. This has direct effect on teachers, whom the Science Board relies upon for the most effectively interpretation of its objectives.

For most of the teachers, especially the younger ones, there was a widespread disenchantment with the Science Schools because many feel their entitlements were not being met.[13] Quite a few were interested in teaching highly motivated students the Science Schools cater for, but could not do so because of materials constraints.

What emerged was the teachers were not attracted to the Science Schools by the same ideals as seen by the policy makers, but by the incentives in the conditions of service associated with working in the schools. To add to this, working for the Science Schools means side-stepping the staid bureaucracy of

[13]. This was forcefully made clear to the Science and Technical Schools Board members by teachers when the newly inaugurated Board went on a familiarization tour between January to March 1985. As the report of the Board states: “Staff employed by the Board on Permanent appointment expressed fear and uncertainty on their future considering that the Board is yet to have conditions and schemes of service from which they can assess their future prospects and benefits on retirement or death.” (Minutes of the Board 17/4/1985).

the Kano State Ministry of Education, giving the teachers a greater measure of self esteem. And since these conditions and expectations were often not met, disillusionment rapidly set in. As the authorities in one ofthe Science Schools admitted,

> "Another problem facing the school is lack of continuity of teaching staff. Trained and competent teachers are not prepared to stay for at least 4 or 5 years. The cause of which is very difficult to diagnose. However, non-provision of car loans and brighter opportunities elsewhere seem the commonest reasons for the turnover of staff. We do get many excellent teachers, but for one reason or another have to leave for another job after obtaining the necessary experience before they are able to make meaningful contribution to the school." (CTV documents 26/1/1986)

And partly as a result of this disillusionment, as well as lack of clarity of what is expected of them from the Science Board, teaching for the teachers in the schools became a routine affair, no more no less than in any conventional schooling system. The objectives of the Science Schools were clear to the teachers, but only by default.

They generally deduce, by the attactive conditions of service offered to them, and the political nature of the Science Board, that the goal of the Science Schools is to enable students to pass their examinations very well and proceed to the university. This was the most plausible rationale offered by the teachers when I attempted to find out if they were aware of the objectives of setting up the Science Schools. But there was no clear science teaching emphasis from the Science Board.

Nevertheless this situation could not have arisen because the goals of the Science Schools themselves were complex. For the most part, it was straight forward project. It does not involve even an orientation for teachers as to what it is all about. Teachers are recruited and posted directly to the schools.

And yet the relative lack of complexity of the Science Schools Project has a surprising side-effect: less was done to enable implementation of the change strategy. This is in contrast to the arguments given by Fullan (1982 p.59) that "while complexity creates problems for implementation, it may result in greater change because more is being attempted." Thus ambitious projects were less successful in absolute terms of the percent of project goals achieved, but they typically stimulated more teacher change than projects attempting less (Berman and McLaughlin (1977) in Fullan 1982 p.59)

This situation poses a dilemma for the change analyst who would recommend simplicity and modest ambitions in educational change strategies, since, as the case of the Science Schools shows, simplicity does not necessarily lead to a more effective implementation. Clearly other equally potent factors must be involved in the successful implementation, and these could include the quality and practicality of learning materials associated with the implementation.

In this, the Science Secondary Schools Project stands out as unique because it is an amalgam of two educational change strategies which evolved under different sets of circumstances as earlier explained.

The fundamental problem not addressed by the new science curriculum used in the Science Schools, and not redressed by the Science Schools was teachers in the Science Schools were either not aware of the extent of the differences between the new science curriculum and the old one, or, if they indicated actual awareness did not see how the new science curriculum personally affects their teaching. And since explicit links were not suggested between the new science curriculum and the way science is taught in the Science Schools by the Science Board, or how it is expected to affect the products of the Science Schools, this leaves the science curriculum open to convenient interpretation from the teachers.

What emerges from the findings of this chapter is political rationales for educational change strategies in Nigeria provide a suitable basis for projecting beliefs about education in social progress, but little attention was paid to the sustenance of these change strategies, or how they fit in with educational realities. The issue facing any educational change strategy is not just of need, clarity, complexity or the quality of the materials used, as identified by Fullan (1982) but the constant production of personnel who identify with the rationales of the change strategy enough to see to its sustenance to achieve a reasonable measure of its objectives. That is the essence of science education as a long term service aimed at radical social transformation.

Chapter 8

Science, Schooling and Manpower Production in Kano State

8.0 Introduction

This chapter analyses the most explicit measures used by the policy makers to determine the outcomes of the Science Secondary Schools Project in Kano State as an educational change strategy aimed at maximizing the production of scientific and technical manpower for the State.

The chapter sets out to answer the following research question: What is the contribution of the Science Schools towards scientific and technical manpower production in Kano? This central research question enables development of sub-questions which provide an analytical framework for the chapter. These are: What are the personal characteristics of the students of the Science Schools? What is their general attitude towards science and careers? In what ways have the schools contributed generally to manpower production for Kano State?

The chapter is divided into three sections. Section I analyses the socio-economic background of the Science School students. Section II analyses the different dimensions of the students' attitudes towards science, as well as their responses towards career choices and their awareness of the expectations of the various careers. Section III analyses the outcomes of the Science Schools project in Kano from policy makers' perspectives.

8.1 Section I: The Science School Student

8.1.1 Socio-economic Characteristics: Paternal Occupation

It has been contended that in educational research, the occupation of the student's father "is one of the most commonly used indicators of the socio-economic level of the home" (Keys 1987 p.37). To determine the socio-economic characteristics of the Science School students, a random sample of 300 in the four Science Schools were asked to provide information about themselves, including parental occupations and education through a questionnaire, whose development is fully discussed in Appendix 3. The findings should be of significance because at the beginning of the Science Schools project, one of the most consistent criticisms against it was it would only cater for the children of Kano State elites. As the Chairman of the Committee that proposed the Science Schools recalled,

> "The chief opposition to the Science Schools was that they were elitist. That is to say only the children of so and so will get admitted there. So we were setting up an elitist thing and this society is not for that kind of thing." (Interview 7/1/1987)

And yet if paternal occupation could be taken as a socio-economic indicator of status, then the expectations of elitism does not seem to apply to the Science School students population of 1986. This is suggested by Table 8.1 which summarizes the free response results of students' paternal occupations. To condense the analysis, only the paternal variables are considered in all discussion of the students characteristics.

Table 8.1: Fathers Occupation By Domicile (N=281)

Occupational Category	City	Town	Village	Total	Pct
Farmer	19	67	96	182	64.5
Civil Servant	21	19	2	42	14.9
Businessman	20	9	5	34	12.1
Teacher	7	5	1	13	4.6
Manual Labourer	4	3	0	7	2.5
Doctor	1	0	1	2	0.7
Engineer	1	0	0	1	0.4
Total	**73**	**103**	**105**	**281**	**100**
Pct	**25.9**	**36.5**	**37.3**	**100**	**-**

A limitation of this Table is the unavailability of occupational norms for Kano State which will show the real distribution of these occupational categories, and subsequently enable determining whether any category is over-represented here.

It should also be pointed out the table is not meant to convey the same information as paternal income, and in my analysis, I avoided implying these occupational categories are true measures of paternal income. Parental occupation, rather than income was asked from the students because of uncertainties as to whether the students can accurately indicate their parental incomes. Moreover, certain occupations have no fixed income. For instance, while the income of a civil servant can be fixed, that of a farmer or businessman is more difficult to determine.

The analytical problems associated with this are similar to those acknowledged by Keys (1987) who, on presenting information about socio-economic status of respondents in her research, cautioned

> "It should be borne in mind when interpreting figures that there is always a measure of uncertainty in the classification of occupations from self-completed questionnaires, particular when the information is supplied by one person about another as when students supply information about their parents." (Keys 1987 p.36)

From Table 8.1, it would appear the predominant paternal occupation is farming, accounting for 64.5% of the total responses. In Kano State, the farming job category is commonly associated with independent subsistence status, and not linked with advanced academic training. Even the distribution of the job categories in domicile is residentially stratified. For instance there were more farming occupations in the villages (96) than in the city (19) or towns (67). The table therefore suggests some measure of relationship between paternal occupation and domicile, with the more modern sector professionals in the City than outside.

The residential divisions into village, town and city are based on my personal classification of the places of residence given by the students. The classification drew from my knowledge of these areas in Kano State. It was also further guided by a consideration of population and provision of social amenities in Kano, these being less as one moves from the City (in Kano State, the City is the metropolitan Kano), to towns and villages. This is more so in Kano which is actually one City-State due to over concentration of socio-economic activities in Kano City. This arose because of historical factors which established Kano City as a very important stage of ancient trans-saharan trade route. The city has also been the centre of government in the Kano Province throughout its history. With the City acquiring such commercial and political prominence, it was inevitable affluence became more concentrated there than in the outer residential areas.

In the light of this, it is therefore interesting to note an association between the level of training required for each paternal job category and residence. Jobs requiring skills associated with academic training are more frequent among City respondents than any other residential category. For instance, 21 or 50% of the 42 paternal civil servants were City residents, while only 5 or 11.9% lived in the villages. The lone Engineer in the Table is also located in the city, while 7 of the 13 teachers were city residents. However, on closer investigation of the teaching job category responses, many of those who indicated this as their paternal occupation also made it clear their fathers were Quranic teachers, rather than teachers in the conventional western conception of schooling.

The table therefore seems to suggest student distribution among the students who participated in this research in the Science Schools does not seem to be affected by paternal occupation. This is to say if these paternal occupations are accepted at their face value, then the generality of the parents of the respondents of the Science Schools were not in position to influence the placement of their children into the schools though socio-political influences.

Further, although in Kano affluence and social influence are most commonly associated with, but not exclusive to, the metropolitan residence, yet the majority of the respondents from the Science Schools do not come from the metropolitan Kano, as suggested by the summary in Table 8.2

Table 8.2: Residential Distribution Among Science School Students (N=296)

Domicile	Frequency	Valid %	Cum %
City	79	26.7	26.7
Town	109	36.8	63.5
Village	108	36.5	100.0
Missing	4	1.3	Missing
Total	**300**	**100.0**	**100.0**

Thus a considerable proportion of the respondents from the Science Schools could be classified as non-City residents. This might be the outcome of the insistence by the Ministry of Education, not the Science Board, that selection of students to the Science Schools must be based on local government representation. As a Senior Assistant Secretary in the Science Board guardedly explained,

> "In 1980 the Commissioner of Education said we have to reflect each local government in Kano in our selection of students. We must have a student from each local government. So after we complete our admission then we have to break it into local governments. When we did that we found some few local governments haven't got even one student. So whether a boy is good or not, actually the best among the worst is the one we take." (Interview 3/10/1986)

This came about because at the beginning of the project, cohort students were selected from the "best" schools in Kano. Such schools tended to be located in, or close to, the City.

And because of the administrative directive that each local government in Kano should be represented, differential criteria for the pass mark in the selection examination were also introduced (see Chapter 5). Table 8.3 further shows the distribution, by local government area, of Science School students who were admitted into two of the four Science Schools in 1985.

Table 8.3: Summary of Students Admitted to the Science Schools, 1985 by LG Area

Ed. Zones	D/Tofa	D/Kudu	Total
Municipal	25	26	51
Hadejia	24	25	49
Gumel	23	25	48
Kazaure	26	24	50
Rano	27	25	52
Gaya	12	12	24
Wudil	22	22	44
Bichi	16	16	32
BirninKudu	13	13	26
Gwaram	29	30	59
Minjibir	23	22	45
Total	**240**	**240**	**480**

Thus because the selection examination was conducted to ensure representation of students from all over Kano State, it is not surprising a great deal of the students were not from the Kano Municipality. Table 8.3 enables a better appreciation of the significance of Tables 8.1 and 8.2, as well as 8.4.

8.1.2 Paternal Education

In the distribution of parental educational qualifications, a similar trend to parental occupation is noted, as reflected in Table 8.4

Table 8.4: Father's Educational Level (N=200)

Educ.Level	Freq.	Valid %	Cum %
Quranic	152	76.0	76.0
Primary	11	5.5	81.5
Secondary	8	4.0	85.5
Tertiary	27	13.5	99.0
Adult Educ	2	1.0	100.0

Missing	100	Missing	
Total	**300**		**100.0**

It is interesting to note the predominance of fathers with only Quranic education as their main educational training (76%), while tertiary education, most commonly associated with professional training at polytechnics and universities, accounted for 13.5% of the educational category. It is however significant to note 100 out of the total 300 respondents did not answer this question.

The absence of parents with high academic training associated with modern sector jobs in Tables 8.1 and 8.4 is also reflected in a variable discussed in Chapter 7 where in a mult-response item, students were asked to indicate what they do if they do not understand a part of their lesson. Only 7 or 1.4% of the total 490 responses indicated asking parents (Table 7.3 p 263). This had the lowest response among all the alternatives given. Even “asking someone else whom you think knows” received a far higher response (15 or 3.1%) than asking parents. The reason for this could be partly accounted by the relative lack of such knowledge among the parents as suggested in Tables 8.1 and 8.4.

Interestingly, an earlier investigation on the socio-economic background of the Science School students revealed a different picture of the status of the student population at the time. In a study of the criteria of selection into the Science Schools, Ekuh (1984) discovered

> “...the Science Secondary Schools students were from urban areas...This ties up with the finding that these Science Secondary School students came from more affluent homes, since affluence is located more in the cities than in the farmsteads.” (Ekuh 1984, abstract p.x)

The residential origin of students in Tables 8.3 and 8.2 did not support this conclusion. But the differences between Ekuh’s conclusions and the findings of this section might be attributed to historical forces which saw more stringent selection process in the Science Schools, especially from 1984/85 when the Science Board was controlled by full membership. The respondents in Ekuh’s research included students taken to the Science Schools during the civilian administration in Kano State (which ended on 31 December 1983) - a period when the Board was without Members, and which made the selection process open to influences. The 1986 sample under went a more careful selection process whose meritorious expectations have been stressed by the Science Board. As the Principal of a Science School emphasizes,

> “The criteria in selecting the students for this school is not based on any social class. Rather it is strictly based on merit, and therefore any averagely intelligent student, no matter his background, can be able to come here if he satisfies those criteria. And certainly, I am proud to say it here that we have an aggregate of students from all sorts of backgrounds. If you want to find children from the most poor backgrounds, you come to the Science School. If you want to find also students from very rich background, you come here. This is because they all come here on basis of merit and their background is not important. Family, social or economic background are unimportant at all.” (Interview 8/10/1986)

If the findings indicated in the tables above and the official assertions are true, then elitist charge to the Science Schools do not seem to be valid in 1986. Moreover, commenting further on the parental background of the students, the Principal of a Science School noted,

> "Majority of the parents are, so to speak, ignorant about the procedures through which the students come to this school. Most parents are not aware. They all of a sudden receive Joining Instructions saying that their children have been selected into one of the Science Secondary Schools. Most of them do not even appreciate what it was. They cannot see the difference between the school in which the child was before and the school he was now coming. They tend to see them as all the same. So most parents are not aware, and they in no way affect influence the coming of the students (into these schools)." (Interview 8/11/1986)

The findings suggested by the four tables in this section therefore discount the expectations a facility such as the Science Secondary School may be used to cater for the children of the few socio-politically powerful individuals in Kano State.

8.2 Section II: Attitudes And Careers

8.2.1 Attitudes to Science

A study of the attitudes to science of students in educational institutions such as the Science Schools would seem almost superfluous. This is because the students are carefully selected and the procedure, according to officials, ensures only students with high aptitude in science are eventually selected. As the Executive Secretary of the Science Board explained,

> "Before the students were admitted, all of them had to go through vigorous selection examinations. There were two stages of the examinations. First the local examination set by the Board itself. Then the TEDRO section of the WAEC was invited to come and administer special aptitude tests on these students to mainly cover verbal aptitude, quantitative aptitude and science aptitude. This was done with a view of getting students who had really the right aptitude for sciences, because you will be wasting your money if you don't get the students with the right kind of attitudes." (CTV Programme Transcript 27/2/1986)

Even if a student has the ability and no interest, the environment of the Science Schools is such eventually an interest either develops, or the student, in keeping with need for peer identification, claims such interest. For instance, in an interview, a former student recalled,[14]

> "When I arrived at the Dawakin Tofa Science Secondary School, I noticed that the facilities in the school, the laboratories and the rest of it, were not the same as in my former school (Wudil Technical College).

[14]. Sarki Abba Abdulkadir, who was the Dawakin Tofa Science Secondary School "star pupil" in 1984. This was because he had the best WAEC GCE O level examination results in the whole of Nigeria in 1984. See Appendix 5. At the time I did the interview with him, he was a second year medical student at Ahmadu Bello University Zaria.

Another thing is that I had the feeling that I was among the best students. Actually since almost all the best students are concentrated in one place, so I knew from then I had to renew efforts if I want to make it because I know everybody who is there is good. And it is helpful." (Interview 29/10/1986)

With this sort of drive, it would therefore be expected some positive attitudes to science are either inherent in the students before they come to the Science Schools, or are developed while there. Significantly, however, it cannot be demonstrated the Science Schools were responsible for any positive attitudes towards science in the students. Nevertheless a study of the schools will not be complete without determining the magnitude of the students' interest in science as a personal investment and as a social process.

8.2.2 Personal Response to Science

The analysis of the students attitudes towards science starts with an investigation of their perception of science as a personal statement, as summarized in Table 8.5. The development of the items is fully discussed in Appendix 3.

Table 8.5 : Personal Response to Science

		Agree		Not Sure		Disagree	
Variable	**No.**	**Resp.**	**%**	**Resp.**	**%**	**Resp.**	**%**
SCI	294	288	98.0	2	0.7	4	1.4
BOR	288	29	21.0	21	7.3	238	82.6
LESCI	284	40	14.1	35	12.3	209	73.6
EASY	284	189	66.5	36	12.7	59	20.8
CUR	299	280	93.6	10	3.3	9	3.0
JOB	286	253	88.5	18	6.3	15	5.2
FRI	299	61	20.4	29	9.7	209	69.9
RELA	294	268	91.2	20	6.8	6	2.0
FATH	286	200	69.9	26	9.1	60	21.0
MOTH	298	159	53.4	35	11.7	104	34.9

Table 8.5 suggests a consistent agreement with all the statements reflecting science as a worthwhile personal investment. Thus there was general agreement among the respondents that Science is interesting (SCI 98%), easy (EASY 66.5%), makes a person curious (CUR 93.6%), and will enable a person to get a job better than any other discipline (JOB 88.5%). Correspondingly, there is less agreement that science is boring (BOR 21%) or that students should have less science lessons than they have now (LESCI 14.1%).

Interestingly, there was also less agreement with the suggestions that respondents make friends only among science students (FRI 20.4%), although respondents generally agree they will encourage their brothers and sisters to also study science (RELA 91.2%).

Parental influence is quite strong with the father (FATH 69.9%) having greater influence on students choice of science, than mother (MOTH 53.4%). This is interesting in that the majority of the respondents paternal occupation is farming (64.5% of 281 as in Table 8.1). The paternal influence might reflect a parental awareness that the traditional Kano expectation that a child will follow the father's occupational foot steps may seem to be waning. This could be because of the realization that science, and by extension modern education, as a career provides a more effective means of social mobility and stable subsistence within the modern sector economy than agrarian occupations. Parents might want their children to achieve more in life than they did, consequently, they might encourage them to study disciplines that will provide greater sense of achievement.

8.2.3 Science in Society

The students' perception of science as a social force is no less positive than their personal stake in the study of science, as Table 8.6 indicates.

Table 8.6: Science in Society

		Agree		Not Sure		Disagree	
Variable	**No.**	**Resp.**	**%**	**Resp.**	**%**	**Resp.**	**%**
BET	298	266	89.3	17	5.7	15	5.0
WAR	296	142	48.0	53	17.9	101	34.1
PATR	298	290	97.3	4	1.3	4	1.3
LESS	298	27	9.1	11	3.7	260	87.2
DISCS	296	24	8.1	6	2.0	266	89.9
RESP	293	208	71.0	65	22.2	20	6.8
KANO	298	268	89.9	16	5.4	14	4.7
SAL	298	235	78.9	36	12.1	27	9.1
SCHL	298	103	34.6	34	11.4	161	34.0
COMP	298	118	39.6	51	17.1	129	43.3

Table 8.6 shows while the majority of the respondents agree science makes the world a better place to live (BET 83.4%), the difference between those who agree science is responsible for war (WAR 48%) and those who disagree(WAR 34.1%) is not too great. Nevertheless the respondents' perception of government expenditure on scientific investment is quite clear. This is seen in the overwhelming disagreement that government should spend less money on scientific work (LESS 87.2%) and that government should discourage study of science (DISCS 89.9%).

Incidently, the difference between those who agree science should be made compulsory for every student in Kano (COMP 39.6%) and those who disagree (COMP 43.3%) is not as big as would have been expected among a group of respondents who want to see more science encouraged in schools (DISCS variable). A similar response is obtained with the variable that suggests scholarships should be given only to students who will study science, where only 34.6% agree compared to the 34% who disagree (SCHL).

And yet the high status given to science, despite this two latter views still remains strong among the students. For instance 78.9% of the respondents agree scientists should be given higher salaries by the government than nonscientists compared to the only 9.1% who disagree, although there is a certain level of uncertainty here since 12.% were not sure (SAL). Surprisingly, although 71% agree studying science will make people respect them more (RESP 71.0%), about 22.2% were not sure, a percentage that is greater than the

6.8% who disagree. Despite this, there was a general agreement Kano should train more scientists than it has now (KANO 89.9%)

The findings of this cluster of variables among the Science School students support similar findings by Keys (1987) in her study of aspects of science education in English secondary schools. A significant emphasis of her survey was determining students' attitudes to science in many scales whose items are similar to the ones discussed here. In her sample, for instance,

> "a great majority of students agreed that science was beneficial to society...78 per cent of them agreed that science was very important for a country's development, 76 per cent that scientific inventions improved our standard of living, and 67 per cent that science was useful for solving the problems of everyday life." (Keys 1987 p.117)

Interestingly, unlike the Kano sample, her respondents were less positive towards statements concerned with spending money on science, since

> "only just over half of them agreed that money spent on science was well worth spending and less than a third believed that the Government should spend more money on scientific research." (Keys 1987 p.117)

And although in my group of variables I did not include facilities to determine whether students feel science is harmful or not, nevertheless, two responses in Table 8.6 did provide some insight into the possible direction of the students attitudes towards whether science is harmful or not. For instance, although 89.3% agree science makes the world a better place (BET), about 48% also agree it is responsible for war (WAR).

8.2.4 Attitudes to School Science

Finally, general attitudes of the respondents towards school subjects and experiments is also as high as their personal commitment to science, although there are one or two surprises, as indicated in Table 8.7.

Table 8.7: Subjects And Experiments

		Agree		Not Sure		Disagree	
Variable	**No.**	**Resp.**	**%**	**Resp.**	**%**	**Resp.**	**%**
CHE	296	247	83.4	19	6.4	30	10.1
BIO	295	223	75.6	35	11.9	37	12.5
PHYI	294	171	58.2	0	0.0	123	41.8
MOREX	294	203	69.0	38	12.9	53	18.0
DEMOS	293	122	41.6	39	13.3	132	45.1
LIKEXP	285	112	39.3	59	20.7	114	40.0
TEA	284	255	89.8	17	6.0	12	4.2

The three science subject (Biology, Chemistry and Physics) came across as being quite popular, but not in the same degree. The least favoured subject is Physics which has only 58.2% respondents agreeing (PHYI) to it being their best subject. This is quite less than the 83.4% who agree Chemistry (CHE) is their best subject, followed by 75.6% who expressed similar opinion about Biology (BIO).

The responses to Physics are particularly interesting because in Chapter 7, one of the more difficult areas in learning science among the Science School students was calculations with 56% of the 257 mult-responses indicating so, which was the highest response among various learning variables (Table 7.6 p 270). It would therefore seem a link is made between finding calculations difficult and not liking Physics to the same extent as other science subjects, possibly because Physics, more than the others, has more calculations.

Similarly, experiments are popular, but with qualifiers. For instance although 69% agree they should have more experiments than lessons (MOREX), only 39.3% agree they like experiments more than listening to lessons (LIKEXP). The strategy of leaving all to the teacher would seem to predominate since only 41.6% agree demonstrations by the teacher are better than doing the experiments themselves (DEMOS), even though 89.8% agree a good science teacher should make students do a lot of experiments (TEA).

These findings concerning the students' attitudes towards experimentation might be attributed to teacher monopoly of equipment during practicals. For instance, in Chapter 7, the time spent on doing various activities during the teaching and learning of Biology and Physics in the Science Schools was discussed. From Table 7.2 (p 257), it emerged the students spent 1.8% of the class time doing experiments. But the majority of the class time of 71.5% was spent by the teacher in delivering lessons to the students.

8.2.5 Attitudes to Further Education

The image of the Science Schools as purely academic centres of learning coupled with the students' high positive attitudes towards science, has an expected impression on the students' view of further education. In responses to an item which asks them to indicate how much further they think they will study before getting a job, an overwhelming majority of 94.6% of the 299 respondents indicated the university as the terminal point of their education. The results are summarized in Table 8.8

Table 8.8: Highest Expected Educational Level (N=299)

Educ. Level	Freq	Valid%	Cum%
Cas	7	2.3	2.3
Polytechnic	9	3.0	3.0
University	283	94.3	94.6
Missing	1	.3	Missing
Total	300	100.0	100.0

But being Science School students was not the only factor accounting for the choice of university over the Advanced Level CAS (College of Advanced Studies) or the Polytechnic. There is research evidence to show this is a trend among students in both developed and developing countries, regardless of the context of their schooling. In a study of Malaysian secondary school leavers' educational and occupational aspirations and job expectations, Ching (1981, 1982) discovered

> "54.4% of the (540) secondary school leavers aspired to a university education. A total of 18.1% desired to join a teacher's college while 10.2% wanted to enrole for courses at the MARA Institute of Technology...while only 4.1% of the students wished to join Polytechnics which offer technical courses at the diploma and certificate levels." (Ching 1982 p.58)

The desire to obtain university education among the respondents was so great that

> "Even among the youngsters who are unlikely to continue their education after Form V, the highest percentage (36.8%) aspired to go to the university...And for the secondary school leavers who were certain of continuing their education after Form V, a considerable majority of 69.2% hoped to attend a university." (Ching 1982 p.62)

Similarly, Peil (1971) in a study of education as an influence on aspirations and expectations among Ghanian secondary school students reported,

> "The most consistent characteristic of school leavers in West Africa (except perhaps those who do not go beyond the third or four year) is that they would rather continue in school...The demand for education seems to be insatiable, and it is less tied to reality than occupational aspirations are. To give a few examples: only 9 per cent of the Middle Form IV sample thought they were unlikely to continue in school on the basis of intelligence, though a quarter felt they would have the money for fees. Six months later, only a quarter were in school, and this was heavily weighted to the urban boys." (Peil 1971 p.13)

There are further studies to support the findings in Table 8.8 For instance, a Liberian study of candidates for the national examinations found virtually all of the junior high school candidates and 90% of the senior high school candidates said they planned to continue with higher education (Azango 1968). Similarly, Clignet and Foster (1966) working in Ivory Coast reported 90% of their secondary school samples interviewed wished to proceed with further full time schooling. Takei, Bock and Warland (1973) in an analysis of the responses of upper secondary male students in West Malaysia discovered even among the lowest social class of Malay males, 87% aspired to attend a university. In another Malaysian study, Lewin (1981) discovered 60.1% of his respondents aspire to university education. And Little (1978), in a survey of occupational and educational expectations of students in developed and developing countries, reports

> "Asked how far they expect to proceed in the educational system, the students in our sample from LDCs expressed an overwhelming expectation that they will reach tertiary level education...The present level or stage of education is not seen as the end of the educational career. Rather, for the vast majority of students the present level of education is seen as a stepping stone to the next level." (Little 1978 p.26)

8.2.6 Career Expectations and Aspirations

Therefore in the context of university training as their expected terminal educational level before getting a job, which confirms similar findings elsewhere, it is not surprising a summary of career choices of the students in the Science Schools indicates an overwhelming choice of non-manual job categories normally associated with advanced specialist academic training, as indicated in Table 8.9

Table 8.9: Occupation After School (N=245)

Category	Freq.	%	Valid %
Human Medicine	136	45.3	55.5
Defence	26	8.7	10.6
Engineering	24	8.0	9.8
Pharmacy	24	8.0	9.8
Agriculture	23	7.7	9.4
Nursing	6	2.0	2.4
Business	6	2.0	2.4
Missing	55	18.3	Missing
Total	**300**	**100.0**	**100.0**

These career categories were from free responses, and not given as choices for the students in the questionnaire. It is not surprising, considering the trend in Table 8.8, 55.5% of the 245 respondents expected to enter a career in human medicine followed, after a wide gap, surprisingly by defence (10.6%) and engineering (9.8%).

It is interesting quite a few of the respondents chose defence as a career on a slightly higher level than engineering and Pharmacy. On an examination of the questionnaires, I discovered of a few of those indicating defence as career choice, air force seemed more favoured than say infantry or navy, and these responses were only in the boys schools since none of the girls indicated wanting a career in defence. As a respondent who wanted to become a pilot explained[15] ,

> "It involves the studying of how to be a pilot and how to be driving aeroplanes both internal and international routes or to be an air force officer."

With the exception of defence, the top career choices of the respondents (human medicine, engineering and pharmacy) are consistent with the expectations of the policy initiators of the Science Schools project. As one of the policy initiators recalled,

> "The Science Secondary Schools were proposed in 1976. The background to the proposal was that the new military administration had just come in, and there were scarcities in all fields, more especially as regards to agriculture, engineering, medicine, pharmacy. The Economic Development Committee proposed that the only way to deal with the

[15]. All students comments are quoted directly from the questionnaires as written by the students without any editing.

problem is actually to create special Science Schools." (Interview 7/1/1987)

These are not the only career choices given by the students, but those selected for economy of analysis and also because they are the focus of the Science Schools project. Some responses were given by a small number of students which could not be categorized here. For instance, some indicated they want to be customs officials and police inspectors. In other cases careers not listed here appeared only as alternatives. For instance a respondent who wanted to become a doctor states he would consider teaching if that was not possible so that

> "I will help my country by teaching or advising the people of my area to hold science hand in hand."

Interestingly, Keys (1987) reported a somewhat opposite finding to that suggested by Table 8.9 in a survey of attitudes to scientific careers among British science and nonscience students. In her sample,

> "The 14 year-olds and the A-level students were asked to respond to a number of statements concerned with the importance of science for employment. (The mean scores of the various groups of students as a whole showed) none of the groups of students as whole held strongly positive attitudes towards careers in science. The 14 year-olds and the A-level science students on average held low positive or near neutral attitudes towards scientific careers." (Keys 1987 p.119)

But the findings in Table 8.9 confirm similar findings of the occupational aspirations of Malaysian secondary school students by Takei et al (1973) who, in their study reported,

> "When asked to indicate occupational preferences without being constrained by reality, the male students in our sample overwhelmingly selected occupations that were classified as either professional-technical or proprietary, managerial, and executive with relatively minor differences between social class assignment. The Chinese tended to select the professional-technical occupations more than the Malays, while the Malays chose the proprietor, manager and executive more than the Chinese." (Takei et al 1973 p.223)

8.2.7 Career Awareness Among Students

But the career choices among the Kano sample are not matched by the respondents knowledge of each career chosen. In a sub-variable, respondents were asked to explain what they think their career choice actually is all about. The summary of the responses is in Table 8.10

Table 8.10 : Knowledge of Occupation (N=168)

	Career Awareness				
Career Choice	**High**	**Fair**	**Poor**	**Total**	**%**
Medicine	0	24	74	98	58.3
Defence	0	1	19	20	11.9

Agriculture	2	9	7	18	10.7
Engineering	1	2	12	15	8.9
Pharmacy	1	1	12	14	8.3
Business	0	1	2	3	1.8
Total	**4**	**38**	**126**	**168**	**100**
%	2.4		22.6	75.0	100

It is interesting only 168 out of 300 respondents actually answered this variable. Judgements about knowledge of career is mine and based on an indirect knowledge of jobs and qualifications. Using this system, I was able to distribute and analyse the explanations given by the students and place the explanations into a category of highly, fairly and poorly knowledgeable. Based on this classification, it is clear the awareness of the students does not match their career enthusiasm. This is because 75% of the 168 respondents provided explanations considered to represent a poor knowledge of their career choices. Interestingly, the least knowledgeable explanations are in the most frequently chosen career - medicine which has 74 poor explanations as compared to no single explanation in which the job of a doctor is very well portrayed by the respondents.

The explanations given by the respondents about their various chosen careers are both diverse and interesting. For instance, a respondent gave the following as the description of a doctor's job "The job involves pharmacist. It is the act of making medicines."

In some of the explanations, it is clear the students have some understanding of their careers choices. For instance, a respondent's view of medicine was

> "The job involves saving lifes, helping Nation and makes one to be patriotic and Nationalism."

This view seems to summarize the political philosophy of medicine, even though the awareness of the career comes across as less concrete. Other explanations were more a reflection of the personal investment in the career than its social function. For instance, a respondent views medicine in the following terms

> "The job involves the work you do in order to feed yourself and cloth yourself. In addition you will get all the necessary needs and make an accommodation."

This seems to reflect a concern with the fringe benefits of being a doctor in the Nigerian society because all the points he mentioned reflect the current struggle for survival among workers. Other explanations of medical profession do reflect an awareness of the rudiments of scientific characteristic inherent in medicine. To a respondent,

> "The job simply involves investigations, practicals and careful observations."

Other perceptions reflect only the respondent's awareness of the school subject combination needed to study medical course in higher institutions. For instance, a respondent's description of medicine is

> "I think the job involves Chemistry, Physics and Biology. The job also include the study of both internal and external structure of man and his associated organisms."

Engineering courses were also popular with the respondents, accounting for 9.8% of the responses. Knowledge of the various engineering courses in this category tended to be less articulate or clear than in the cases of medicine. For instance, according to a male respondent who wanted to "become a mechanical engineer,"

> "I think the job involved physics, technical drawing, mathematics and English."

Similar, and often vague explanations were recurrent in the cases of other branches of engineering. An Agricultural Engineering aspirant explains it is

> "...the study of animal science and plant science and the rest of them."

Some of the respondents see a social purpose in their career choices and were able to make links. For instance, an electrical engineering aspirant explains,

> "...if a person becomes an electrical engineer, he will be work in NEPA (National Electric Power Authority) or his workshop."

The idea of workshop gives an image of self-employment using skills learnt in the process of technological training which also reflected a current drive of the Nigerian government towards self-sufficiency. A similar explanation is given by a respondent who explains engineering involves

> "...the repairing of an engine, e.g. motor cicle or electric machine."

Agriculture, like engineering also received some responses (9.4%), and like engineering and medicine, its perception among students is quite diverse. A male respondent who wanted to become an agricultural officer explains it involves

> "The distribusion of fertilizer, farm tools etc to farmers and moreover they inlight farmers on modern farming."

A concern with helping the nation also figured in some of the responses, although the rationale is often vague and circular. For instance, another respondent wanted to become an agricultural officer "so as to help the nation." His view of his career expectations were

> "I think the job involves researches, observations etc. But to me I would like to be a farmer as to performed experiments, researches and observations."

Other views of agriculture with strong base in scientific mode of thinking are also provided. An explanation from a respondent who wanted to become "an agriculturist" is

"It involves the study of plants and animals. It also involves the caring of plants and animals. It involves the research and provide new breds of plant and animals."

This explanation, which started as vague soon changed into an interesting portrayal of genetic manipulation associated with agricultural practices in Nigeria. Similar explanations are found, but with a more explicit local flavour, as another explanation shows

"The job involves the studying of the problems of the local farmers and solving it. It also involves the producing of new varieties of crops and new breeds."

Pharmacy is another choice favoured by the respondents and its explanations are also quite interesting, although from the categorization of the students's job description, a majority of the respondents who selected it exhibited a poor working knowledge of what it actually involves. For instance, of the 14 respondents who chose it, 12 provided what I adjudicate to be a poor portrayal of the profession. A typical response is

"I want to go to the university to read permacist. Well I can't describe it."

Finally, an insightful portrayal of Pharmacy is offered by one candidate, which is

"It involves making researches on different kind of medicine and the discovery of some medicines of a particular disease and their function in the human body."

Thus the various responses of the students towards their career choices reflect a diverse range of awareness of what each career entails. However, it is only in few cases that links were suggested between the science learnt in the school, and the career the respondents aspire to. And because there were few career choices not connected with advanced academic training, it is not surprising to note a mere reshuffle of the career choices when the students were asked to indicate what they "really" expect to do after leaving school, especially if they were not able to follow their initial career choices. The summary to this is in Table 8.11.

Table 8.11: Alternative Occupation (N=207)

Career Category	Freq.	Valid %	Cum. %
Agriculture	42	14.0	20.3
Engineering	37	12.3	17.9
Pharmacy	33	11.0	15.9
Human Medicine	32	10.7	15.5
Business	31	10.3	15.0
Defence	24	8.0	11.6
Nursing	3	1.0	1.4
Marriage	3	1.0	1.4
Petty Occupation	2	.7	1.0
Missing	93	31.0	Missing

Total	**300**	**100.0**	**100.0**

It is interesting to note Agriculture emerging as most frequently chosen alternative occupation, especially as in Table 8.1 64.5% of the respondents indicated their paternal occupations as farming.

Indeed most of the reasons given for agricultural involvement suggests students simply wished to go back to the farm via academic procedures such as getting qualifications in the subject first. For instance a student who wanted to be "an agricultural mechanics" explains he "will be a poultry farmer" if that does not materialize. Similarly, another respondent who wanted to be "an extension worker" explains,

> "If I don't do this I think I will be a farmer with my little knowledge of agriculture."

Another who wishes initially to become an engineer, expects that

> "If I don't do this I think that my job should be farming."

It would appear agriculture is an occupational meeting point where all the careers converge as the "last resort" in life. Its choice as alternative "real" occupation suggests the popularity of the subject in the school curriculum. It also suggests an awareness of its potential as the only subject whose benefits can be put to immediate use for sustenance in the increasingly competitive and deteriorating Nigerian economy. This finding confirms a similar finding by Peil (1968) who analysed the occupational aspirations of students from the Brong-Ahafo and Volta regions of Ghana and discovered

> "In the village served by the Volta Region school, the chief and many other adults had completed middle school, so farming was not regarded as beneath one's education. Several of the Volta Region boys had expressed very high aspirations, but, when asked what they really thought they would do after leaving school, 60 per cent thought they would farm. The only major alternative was teaching. A majority of the boys in the rural Brong-Ahafo school thought they would teach, but farming came second." (Peil 1968 p.76)

Other choices of what students feel would be their "real" occupations reflect the nature of the course selection mechanism in processing forms for higher institutions, rather than an awareness of the labour market forces. Engineering, Pharmacy and Human Medicine most likely reflect the students' "second choices" in course selection for higher education. This is because in Nigeria it is the norm for students to think about occupations in terms of further academic training; it is not therefore surprising most alternative or expected "real" occupations have strong academic overtones. For instance, a respondent who wanted to become a pilot states,

> "I will become an engineer because it is my second choice."

Similarly, a respondent who wanted become a doctor states, "If I don't do medicine I will read Pharmacy." Others were less clear on what their real occupations will be, and combine their answers with an aspiration and expectation. For instance, a respondent who wishes to become a doctor states,

> “If I don’t do this, I will like to do engineering or become a trader.”

Some respondents could not bear to face the possibility that they may not enter their stated careers, as such they did not provide “alternatives” and indicated why. A respondent who wanted to become a doctor states,

> “If I don’t do this, I would still try my possible best to see that I do it.”

It is interesting only three respondents list marriage as alternative real occupation. The responses were from the girls school sample and reflect a new dimension of female perception to education in Kano. Previously, it has been the norm for girls to get married immediately after their secondary education. Indeed, as the authorities of the girls school told me, many of the girls were already married, and simply awaiting completion of their secondary education before going to their husbands. That only 3 indicated willingness to get married (presumably from a sample of those who are not married) seems to suggest the environment of the Taura Girls Science School may have an influence in making students develop interest in higher education.

In a further survey of the results of the questionnaire responses, the only careers chosen by the female students were Human Medicine, Pharmacy, Nursing and Engineering. These were given the same value as alternatives and respondents listed them as their real expected occupations, with the inclusion of marriage. However, none of the female respondents could provide what is adjudicated as good explanation of her career choices. For example, a respondent’s view of medicine is

> “I think the job involves studying some part of the body like a dentist. It involves doing theatre and other things.”

Another female respondent suggest medicine

> “As we know, involves treatment, health”

Yet still another medical aspirant explains that medicine

> “Involves the study of chemistry, biology and physics. It qualifies you to become a doctor.”

The variable asking students list their expected “real life” occupations seeks a distinction between occupational expectations and aspirations and raises some analytical problems which are not peculiar to this research alone. In making such distinctions as part of a research design, Takei et al (1973) proposed

> “socio-economic aspirations should be treated as constituting circumstance-free wishes that can be freed theoretically from the constraints of perceived reality...Socio-economic expectations, on the other hand, should be viewed as circumstance-bound responses which

are subject to being strongly influenced by perceptions of reality." (Takei et al 1973 p.218)

Similarly, Little (1978) in a discussion of the distinction between aspirations and expectations in educational research argues,

"A number of studies confirmed the hunch that students in secondary schools in many developing countries were "unrealistic" about their futures. Indeed, many of the questionnaires request students to look at their futures 'realistically' when answering questions..." (Little 1978 p.18)

Little calls for a consideration of the reasons behind career expectations of students in developing countries instead of dismissing such expectations as unrealistic by stating

"Realism versus unrealism is one way of explaining away the difference between student in developed countries and students in developing countries. But is it sufficient? Indeed, is it a fair explanation at all? The problem with a word like 'unrealism' is the other ideas associated with it - there is the implication that the root of the problem lies within the person himself, that the person is being somewhat irrational and is either ignorant of or fails to understand the 'facts of the case' (the scarcity of school places and non-manual jobs)." (Little 1978 p.19)

And yet the findings in this section does reflect students' general "unrealism" and ignorance of the 'facts of the case.' This is because even though data about employment and occupational categories in the Kano State economy are not discussed here, the various comments of the students regarding their perception of the careers attests to this. Further, the level of awareness of the individual chosen careers of the students reflected in Table 8.10 is a point that bothers the authorities of the Science Schools. In Dawakin Tofa Science School for instance, a highly organized Guidance and Counseling service reported in 1981,

"Most of the work done in past two years has been in guiding the final year students in their preparation for the next stage of their career. Most of them have been found to be without much knowledge of the various course open to them, or of the qualifications to be obtained before hand. Many are vaguely optimistic that somehow or other, they will end up as doctors or engineers." (Dawakin Tofa Guidance and Counseling Report 12th December 1981; see Appendix 5)

And yet the situation is partly caused by both employers who could provide adequate information about their respective organizations. The Guidance and Counseling unit of the Dawakin Tofa Science Secondary School proposed strategies aimed at making students aware of what each career prospects are, and reported,

"The first thing to do, therefore, was to dispel this ignorance by disseminating basic information about higher institutions. A duplicated letter requesting for such information was dispatched to many higher institutions throughout the country, as well as to major industries. The response was disappointing. Most did not reply at all, and those which did failed to send material which would interest applicants. The various prospectuses and calendars received have not proved very useful...Only the Nigerian National Petroleum Corporation, Kaduna Refinery Project supplied attactive and interesting documents." (Dawakin Tofa 12th December 1981)

The problem is also partly logistic which does not reflect the individual Science Schools' commitments to dispelling the students' ignorance about the various careers. The Dawakin Tofa document further reported,

> "Ideally written information should be supplemented by visits to a cross-section of higher institutions and technological enterprises. Some establishments have indicated that they are willing to show small parties of students around their premises. Unfortunately the problems of arranging such visits are formidable." (Dawakin Tofa 12th December 1981)

This situation prevailed up to 1986 when the present research was conducted. In an interview with a Physics teacher in the same Science School, I raised the issue of field trip who explained,

> "We have never gone out on field trips. Boys at this school are not going to benefit much from the visits. If circumstances do warrant it, we may take them." (Interview 16/11/1986)

With this situation prevailing, it is not therefore surprising a considerable majority of the respondents expressed what can be adjudicated as poor knowledge of their various career aspirations in Table 8.10, and yet despite this, still as alternatives, careers with high academic requirements (Table 8.11).

The analytical problems associated with this variable were taken into consideration before the final questionnaire was written and submitted to the students. Attempts were therefore made to avoid wording where the respondents have to make distinctions between their "expectations" and "aspirations" This is because as Tables 8.9 and 8.11 clearly show, the dividing line between expectations and aspirations among the Science School students is quite grey.

But it should not be surprising the Science School students show high educational and occupational expectations. Indeed the circumstances of their schooling expects such attitude. The schools were established for the sole purpose of training students for further education. In my interviews with officials, this point was strongly put across to me. For instance, according to the Executive Secretary of the Science Board, when explaining the lack of industrial representation on the Science Board,

> "We have nobody from the industries, because you see when you are training people at the secondary school level, you are not training for a career as such. I mean you a giving them a basic education, you know, for take off for post secondary level. It is only when they go to the universities or polytechnics that they really get inclined to a particular (occupational) area." (Interview 23/10/1986)

Thus the absence of any attempt to make linkages between the world of schooling and the world of work in the mechanism of the Science Schools provides a basis for further confirming their purely academic orientations, even though it is acknowledged by the Executive Secretary that not all the students will be successful in their aspirations of getting to the universities or polytechnics. And because this point serves to show the the over-concentration of efforts in one dimension of the Science Schools project, I pursued it further with the Executive Secretary pointing out the possibilities of industrial linkages to absorb the "casualties" of the Science Schools. The reply was rather interesting in that the Board does not seem to be convinced of such strategy because

> "It is not easy. It is not easy you employ somebody who has no skill whatsoever in the industry. It is not easy because industries normally do not train very much; they can only help to retrain. It is not like the technical colleges where kids who finish could be absorbed into the industries where they retrain them, improve them and utilize them. But with Secondary Schools where you just finish without any skill, really, because the training does not provide any skill acquisition; it is purely academic...We are not training anybody for anything. We are giving sound basic education. Sound basic education. That is all. So when they finish from here they go into various areas." (Interview 23/10/1986)

This perception of the Science Schools as institutions providing purely academic rather than academic and occupational skills (as the developers of the Nigerian science curriculum wished in the curriculum) is further emphasized in the overall conception of the Science Board (see Chapter 5). The findings in this section therefore support the expectations and aspirations of the policy planners of the Science Schools project in that students in the schools express both high positive attitudes to science and scientific careers, even though their awareness of the careers is quite low.

8.3 Section III: The Outcomes of the Science Schools Project

A discussion of the outcomes of the Science Schools project in Kano is not possible without some qualifier. This is because Chapters 5 through to 7 have discussed the various outcomes of the project in terms of its origin and implementation. But outcome has a different meaning for an analyst and a policy maker. In the policy maker's perspective, the term is used to emphasize the successes of the Science Schools project. With regards to this, it should be recalled in outlining the rationale for the establishment of the Science Schools, the Kano State government observed,

> "Although Secondary Education in the state has expanded very considerably over the last few years, the number of students graduating in Science and technical subjects remains a very small fraction. Our schools and universities are still dominated by the study of liberal arts. In Kano State for example in 1975/76 WASC, only 12% of our candidates took Science subjects...In 1977...it was noted that although the first indigene of Kano State in the field of medicine graduated over 20 years ago, yet the State cannot boast of more than 10 medical doctors who are indigenes of Kano State." (Kano State 1979b p. 43 and 139).

This basic rationale therefore gives two areas of analytical focus; first is the volume of science based secondary level graduates produced by the Science Schools since their establishment. Secondly, the placement of these students in science and technology disciplines in higher institutions.

8.3.1 Examination Outcomes

The first emphasis asks, to what extent has the establishment of the Science Schools made any difference to the number of GCE science graduates from Kano? This is difficult to answer totally without accurate information about the number of science graduates produced by secondary schools in Kano before the establishment of the Science Schools. But according to figures made available by the Science Board, the Science Schools have graduated 2,437 students from 1980 to 1986. However, the most important measure of success of the project used by the Board is the GCE O level examination results of these students, which are shown in Table 8.12.

Table 8.12: Science Schools Credit Level GCE Ordinary Level Examination Passes, 1980-1986

Subject	**D/Tofa**		**D/Kudu**		**Taura**		**Totals**		**%**
	No.	**Crd**	**No.**	**Crd**	**No.**	**Crd**	**No.**	**Crd**	
Chemistry	1053	467	1235	528	127	28	2415	1023	42
Maths	1054	313	1269	511	129	8	2452	832	34
Biology	1053	272	1238	523	129	35	2420	830	34
Physics	1053	223	1237	522	129	15	2419	760	31
English	1053	88	1237	165	128	12	2418	265	11
Average	**1052**	**272**	**1243**	**449**	**128**	**20**	**2423**	**742**	**30**

(Source: Science and Technical Schools documents. Figures exclude Taura 1986 results. See Appendix 5 for derivation)

The left column under each school represents the total number of students who took the examination, while the right column indicates those who passed. In the interpretation of Table 8.12, it should be borne in mind the emphasis in discussing these examination results is not on the internal consistency of the examination procedure, its validity, or the criteria of references used to derive the scores.

Further, only the results of the five main subjects are reproduced here. These are Biology, Chemistry, Physics and Mathematics and English Language. These subjects are considered here because a student must pass them all at credit level in the GCE ordinary level examination before being allowed to study any scientific or technological course in any Nigerian higher institution. They effectively determine a student’s future career in science or technology in Nigeria, especially if such career is to be derived after post-secondary education.

Table 8.12 indicates many of the students from the Science Schools have obtained credit level results in the main subjects required for advanced study of scientific and technological disciplines, with an average credit level pass of 30%. The significance of this figure is more so when it is realized the examination figures did not reveal how many students got all the five credits required for further studies.

Interestingly, in a study of the predictive validity of the entrance examinations into the Science Schools on the performance of students at different levels, including the GCE ordinary level, Ubale (1986) discovered,

> "The assumption that Science Secondary School students would significantly perform higher was not adequately established...Furthermore, the first batch of the Girls' Science School (at Kura) had lower overall mean performance than even the other secondary schools. It could therefore be deduced that the first four batch of students that graduated from the Science Secondary Schools for boys and the first batch of Girls Science Secondary School did not perform any better than science students that graduated from other secondary schools." (Ubale 1986 p.78)

However, when the overall pass level results of the students in the Science Schools are taken in consideration, a slightly different picture emerges. Table 8.13 presents the overall pass results of the Science Schools in the five core subjects.

Table 8.13: Science Schools General GCE Ordinary Level Examination Passes, 1980-1986

	D/Tofa		D/Kudu		Taura		Totals		
	No	**Passes**	**No**	**Passes**	**No**	**Passes**	**No**	**Passes**	**%**
Chemistry	1053	690	1235	849	127	63	2415	1602	66
Maths	1054	610	1269	892	129	34	2452	1536	62
Biology	1053	504	1238	858	129	100	2420	1462	60
Physics	1053	473	1237	924	129	50	2419	1447	59
English	1053	368	1237	432	128	35	2418	835	34
Average	1052	529	1243	791	128	282	2424	1376	56

(Source: Science and Technical Schools documents. Figures exclude Taura 1986 results. See Appendix 5 for derivation)

Table 8.13 indicates an average pass rate of 56% in the five core subjects in the Science Schools, and reflect the sort of emphasis of the outcomes of the Science Schools project given by the Science Board. For instance, during the 28th Meeting of the Board held on 20th November 1985, one of the items on the agenda was the 1985 examination results. With regards to this,

> "The Board noted with satisfaction the performances of students from the Science Secondary School, Dawakin Kudu, Dawakin Tofa and Kura (i.e. Taura) during the 1985 May/June GCE examinations."

However, the Academic Committee, at the same meeting was not satisfied with all aspects of the results and expressed,

> "the Committee was not satisfied with the performance of the Science Students at Govt Girls Secondary School, Kura."

The Committee recommended to the Board generally

> "the Principals should be asked to explain why, in subjects the students performed below average (50%)."

It should be borne in mind when analysing the figures in Table 8.13 they include both credit and non-credit scores. It is interesting results in English Language seemed to be the worst among the five core subjects, despite the prominence of English as one of the papers to be passed in the selection examination to the Science Schools, and despite the students receiving six hours of English Language instruction per week (the same only with Mathematics) - more than in other science subjects. As the Guidance and Counseling unit of the Dawakin Tofa Science School observed in its report for 1983,

> "Failure in English language continues to be handicap to many students. Eleven students had very good overall results marred in this way. Of these eleven, two were turned away for this reason from the University of Nigeria, Nsukka where they had been provisionally admitted to read Electrical Engineering." (Dawakin Tofa Guidance and Counseling Report, 22nd April 1983).

Significantly, the Academic Committee of the Science Board, at the 28th Meeting of the Science Board held on 20th November 1985 also made similar observations about students performance in English Language where

> "The Committee noted the students' poor performances in English Language. This could be due to the general trend Nation wide where-by we have inadequate facilities and half-qualified teachers right from Primary Schools to secondary schools. However, we should await the WAEC comments with regards to poor performance in English."

But it is curious the Science Board has to wait for the WAEC to diagnose a situation which is peculiar to individual schools. Moreover, with six periods a week and substantial resource allocation more than conventional schools, as well as the power to recruit its own teachers directly (teachers who should not be "half-qualified"), it would seem the Board is uncertain about the strategies it should take to reduce the problems of poor English Language performance among the students.

But no matter the analytical interpretation given to these results, the figures in Table 8.12 and 8.13 indicate the production of a large number of science based graduates, which was made possible by the establishment of the Science Schools in Kano. This has led to a considerable degree of satisfaction by Science Board officials and school authorities that the Science Schools project has produced the required number of students to proceed to higher institutions to study science and technology disciplines. As the Executive Secretary of the Science Board explained,

> "Our achievements have been that we have produced the caliber of students envisaged in the programme. Obviously Kano State wanted to produce these kids who are rich in science background for their degree courses. Luckily enough, we have been able to produce these kids. I'll say on the average between 50-60% of those students in the schools meet university admission requirements. One thing that Kano State has

been quite lucky with this programme is that in almost all universities, states have quotas for admission into various faculties. In the past Kano State has been lagging behind in the science based areas. But with the maturity of the Science Schools we have been able to get our students in all areas where our quota is earmarked. In fact in some cases we even fill up the quotas of other states." (Interview 23/10/1986)

Similar observations were made by the Technical Adviser of the Science Board who was also the second Executive Secretary of the Science Board:

> "The setting up of the Science Schools has a tremendous impact on Kano State. Our quota places in Nigerian universities which were never filled up before the creation of the Science Schools have now been filled up and we are now even taking the places of States like Sokoto and Niger because they don't have the students! So universities would rather take our students as replacement to those students who could not take those places. Our students dominate the School of Basic Studies in Ahmadu Bello University, Zaria. Ask the Joint Admission and Matriculation Board, WAEC, almost everybody, they will tell you the same success story. The establishment of these schools has led our boys to go to universities other than the ones in the North. We have have students at the Universities of Ife, Nsukka, all sorts of areas where you will never believe you will get Kano State students in universities." (Interview 29/9/1986)

A more concrete realization of the expectations behind the Science Schools project is reflected in Table 8.14 which shows the distribution of the students who graduated from the Dawakin Tofa Science School from 1980 to 1982.[16]

Table 8.14: Dawakin Tofa Science School Student Placement, 1980-1982

Placement	**1980**	**1981**	**1982**	**Total**	**Pct**
Universities	24	16	32	72	23.2
Polytechnics	29	34	52	115	37.0
Repeating O Level	0	4	0	0	4
Working	12	4	14	30	9.6
Unemployed	0	0	3	3	1.0
Unknown	16	13	57	86	27.7
Totals	**85**	**67**	**158**	**310**	**100.0**

(Source: Dawakin Tofa Science School Guidance and Counseling Documents, 22nd April 1983)

Although there were quite a few students whose locations were unknown from Table 8.14, nevertheless it does give an idea of the distribution of the students of the Dawakin Tofa Science School since the students started graduating in 1980.

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[16]. Only the information from these years was available. The Dawakin Tofa Science School features more prominently because the school seemed to be the most documented of the four. All information can be obtained in printed form, unlike in other schools where I had to rely on statements from school authorities. However, the Dawakin Kudu Science Schools has also a document detailing only the number of students qualified to gain university admission (see Appendix 5). But the figures in Table 8.14 are based on information given by the actual students in these places to Dawakin Tofa school authorities as part of a follow up service.

8.3.2 Labour Market Implications

The second analytical focus of the outcomes of the project asks to what extent has the project provided a basis for specialized manpower production in the areas required? As with the first focus, this also has its problems, not the least of which follow up services do not exist within the Science Board, which will enable more accurate investigation of the various careers of the former students. However, a population check on the distribution of the former students in various courses in three universities in Northern Nigeria, Ahmadu Bello University at Zaria (ABU), Bayero University, Kano (BUK) and University of Sokoto (SOK) provides an indication of the discipline specialization of 308 of the former Science School students. This distribution is shown in Table 8.15

Table 8.15: Course Distribution of Science Schools Students In ABU, BUK and UNISOK 1984-86

			Graduation Year		
Course	**No**	**%**	**ABU**	**BUK**	**SOK**
Science	87	28.2	1987	1989	1990
Engineering	40	12.9	1989	1988	-----
Agriculture	39	12.6	1989	----	1990
Human Medicine	22	7.1	1989	1991	1991
Pharmacy	13	4.2	1988	----	----
Environmental Design	11	3.5	1988	----	----
Vet Medicine	6	1.9	1989	----	----
SBS-Science*	87	28.2		----	----
Nonscience:					
LibrarySci	1	0.3		----	----
Education	1	0.3		----	----
Business Adm.	1	0.3		----	----
Total	**308**	**100.0**			

*(Source: Science and Technical Schools Documents. *SBS - School of Basic Studies; preliminary and non-faculty)*

The expected year of graduation of the most recent student in that course is also given. This means, for instance, by 1991 Kano State expects to have 22 doctors (human medicine) since by then all of them will graduate from their courses, although 11 of the 22 potential doctors will graduate from ABU by 1989, the rest from BUK and Sokoto until 1991. It should be emphasized the figures refer only to students in three universities. Other former Science School graduates from other institutions (Universities of Maiduguri, Ife and Nsukka where they are found) are not included. As such the figures in each subject discipline could be higher.

Similarly, by 1990, Kano State expects to have 87 scientists graduating in various disciplines ranging from Biochemistry, Microbiology, Physics, to Computer Science and Chemistry. Engineering, like medicine is also a discipline for which the policy initiators of the Science Schools expected high turnover. It is therefore significant to note 40 engineers will be available to Kano State by 1988 from these two of the universities in various sub-disciplines which included civil, mechanical, agricultural and chemical engineering.

The impact of the Science Schools, especially in the production of so many science students from Kano State in institutions of higher learning, especially in

Northern Nigeria has not gone unnoticed. This was indicated during the 1985 Macroscope event in the Ahmadu Bello University Zaria. Macroscope is an annual event organized by the Faculty of Science of the university, and features several scientific activities designed to promote the teaching, learning and use of science at all levels of formal education in the catchment areas of the university. Not only did the Dawakin Tofa Science School won the third best position during the events, but the Permanent Secretary, Kaduna State Ministry of Education who was an observer at the events, remarked,

> "Having realised the fact that, Kano State can now fill in its quota in the science disciplines in our higher institutions, as a result of the large number of scientifically sound students it graduates every year from its Science Secondary Schools, Kaduna State government has now completed every plan to follow its footsteps. From the next academic year (1986/87), every Local Government Area in Kaduna State will have a full-pledged Science Secondary School." (Quoted in a speech delivered by the Principal, Dawakin Tofa Science Secondary School during the Parent Teacher Association General Meeting of the School on 23rd November 1985).

Other States in the Federation, especially in the North eventually followed suit, and Kano State Science Schools provided models for development of similar schools. As the Principal of the Dawakin Kudu Science School explained,

> "The impact of the Science Schools is not only in the State, but nationwide. As a national awareness all over the country they know the Science Schools, especially in the fields of academic quiz competitions and exhibitions. The contributions of the schools actually made the State to be known all over the country. And that is why other States are trying to copy the idea. Many Commissioners for Education from other States came here to find the secret behind the Science Schools; States like Plateau, Sokoto, Benue and Kaduna, many others, and they have started building these Science Schools." (CTV Programme Transcript, 27/2/1986)

The importance of this for Kano State is seen in an appreciation of the rationale of establishing the Science Schools by Ado Gwaram, the first Executive Secretary of the Science Board, who observed,

> "We had so many uncle toms, cold feet and the rest of it all along, but I think the end justifies the means. What we have produced with the Science Board has now cleared everything. Later on even those who are opposed to the idea saw that the salvation was in the Science Schools. We produced the best, we had the best. The next set of doctors we are going to have this year from the Ahmadu Bello University Teaching Hospital are going to be all 'yan Kano (Kano indigenes), and Kano for the first time will have 20 doctors this year; all 'yan Kano, all Musulmi (Muslims) and they were all from Science Secondary Schools. They will make impact because everybody will see doctors in Murtala Muhammad Hospital, very many of them *suna Assalamu Alaykum, sai an jima,*

wane.[17] And they are all from the Science Secondary Schools." (Interview 22/2/1987).

Interestingly, none of the officials I interviewed was willing to consider any unexpected outcomes of the Science Schools project. However, the Executive Secretary was able to state,

> "Well I anticipate the Science Schools will create positive and negative problems obviously. Now everybody is smiling they are doing well, students are going into universities. They are being absorbed, they have started graduating and they are coming out. But certainly, within a space of ten years probably from today, there may be an over production of science graduates in Kano State. In fact it won't be ten years. In the next seven to eight years there will be an over production of science based graduates from the Science Secondary Schools." (Interview 23/9/1986)

The most important implication of this, according to the Executive Secretary is in employment prospects, and within the years specified, it would not be unusual if, with the output of science based graduated produced by the Science Schools the schools enabled the production of highly qualified unemployed manpower. Nevertheless, the commitment of the Kano State government to the Science Schools project remains high. As the then Military Governor of Kano State, Air Commodore Hamza Abdullahi stated during an official visit to the Dawakin Tofa Science School on Tuesday 8th May 1984,

> "This college is no doubt a sense of pride to this State in view of its academic performance at State and National level in particular since it is a Science oriented secondary school. Its performances have convinced the government in the need to provide more its kind." (Visitor's book comment, Dawakin Tofa Science School).

8.4 Conclusions

I have departed from the normal procedure of creating a whole section for my conclusions. This is because the conclusions to the entire thesis are fully outlined and discussed in the next, final Chapter. However, from the various data presented in this Chapter, the students in the Science Schools show a high positive attitude to science in various dimensions, as well as positive orientation to scientific and technological careers, although their awareness of their chosen career choices was not matched by their career aspirations.

The data presented also does not indicate a relationship between paternal occupation, the students' career aspirations and expectations. And contrary to an earlier research on the socio-economic status of the Science School students, the findings of this chapter suggest a great majority of the students were non-City residents, and therefore may be in the school through a process other than parental influence and affluence associated with metropolitan residence.

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[17]. Literally: "peace on you, see you later" This linguistic lapse was used by the interviewee to convey the impressions of identification between the doctors and the patients in the hospitals since they are now the same, as opposed to previous years when expatriates and other Nigerians beside Kano indigenes dominated the medical field in Kano; see Chapter 5.

The chapter has confirmed studies carried out in various developed and developing countries regarding the aspirations and expectations of students. In common with other students, the Science School students integrate their academic and occupational aspirations with their expectations.

The outcomes of the Science Schools project also seemed to be consistent with the expectations of the policy initiators of the project. But although the students in the Science Schools have high positive attitudes to science and careers, there was no evidence this was because of parental influence. Moreover, there was also insufficient evidence to enable concluding the Science Schools were responsible for the development of the various aspirations and expectations of the students. But from administrative perspective, there was a considerable satisfaction from policy makers that the project has achieved a reasonable measure of the outcomes it was set to achieve.

Chapter 9

Conclusions

Science Education As A Development Strategy In Kano State

9.1 The Study and Its Background

The purpose of this research has been to determine the mechanism of initiation and outcomes of the Science Secondary Schools project in Kano as a long term scientific and technological manpower development strategy. Although at the end of each of the data based chapters (4 through to 8) various conclusions were drawn and linkages made with the main theoretical framework discussed, this chapter concludes the research by drawing together the various findings and discussing them within the broader theoretical frameworks discussed in Chapter 2, using the research questions identified in Chapter 1 as analytical guidelines. The discussion is divided into three themes which trace the origin, characteristics and outcomes of the Science Schools project. It also identifies areas of the project which need further investigation.

9.2 Origin of the Science Schools project

From the research evidence, the purpose of setting up the Science Schools project in Kano State was to enable a more effective interpretation of science in social transformation using a specialized medium of science teaching and learning. However, the intellectual advancement of the students of the Science Schools as envisaged by the most prominent rationales of the science education reform movement did not emerge as a primary concern of the project. This situation came about because while there was extensive problem diagnosis in the process leading to the establishment of the project, there were no clear specifications of how the project can achieve its expected outcomes.

The most striking observation about the origin of the Science Schools project in Kano is it was an original idea. And unlike the generality of science education reforms, it was not the product of a professional science teacher organization pressure tactics. The analysis that science education in Kano was not providing adequate opportunities to pupils from Kano to study scientific and technological disciplines was made only in retrospect. It was not part of the rationale to establish the project. It was thus not a direct outcome of educational antecedents. This is to say it was not conceived primarily as an educational change strategy, but as a social change strategy. It was also neither adopted nor adapted from anywhere else, and appeared to be the first of its kind in Nigeria.

Yet it is the originality of the Science Schools project that caused some of its problems. Not because there was no Nigerian precedent to guide its development, but mainly because its needs were determined by economic and political, rather than academic priorities. But these sources - administrative and academic - are not mutually exclusive. After all, economic and political influences were a powerful stimuli to innovations in science education - as witnessed to evolution of the science curriculum reforms in the early 1960s.

But economic and political priorities, as bases for science education reforms, often ignore the academic priorities of science education. Further, extensive consultations with professional science teacher organizations such as existed in Kano at the time, and school principals were not sought. This eroded a considerable degree of good will from those who would have co-operated, particularly school principals, in making the initial stages of the project relatively uneventful. Neither was there felt any need for trial of some of the aspect of the project as a whole. Consequently unanticipated problems such as getting the students to cope with the demands of the Science Schools which did surface later were unplanned for.

And the subsequent development of the Science Schools suggest policy implementation in Nigeria is not reliant on the emergence of the policy as a rational or empirically validated strategy for social transformation, but the way socio-politically powerful individuals connected with the policy became committed to it.

The effect of power in policy survival as it relates to the Science Schools is better appreciated against the backdrop of the mechanism by which the needs for any specific policy are identified. The classic problem solving tradition as suggested by Havelock and Havelock (1973) has been to devise ways of finding out the nature of the problem, the solution and the side-effects of implementing them. Accurate and rational identification of the problem would seem to provide a basis for having greater faith in the feasibility of the solution suggested.

This strategy for solving social problems through the Science Schools project was not fully followed. The strategy that emerged was predominantly power-coercive. The use of power in ensuring the implementation and survival of the project was necessary because clearly, the nature of the opposition to the Science Schools project in Kano was such that other strategies requiring elements of dialogue and conviction, e.g. research development and diffusion, would have hardly made any difference to the resistance to the project.

The emergence of power-coercive strategy in the Science Schools project, did not concur well with Havelock and Huberman's (1978) findings that there was a reluctance in implementing educational changes to respond to some of the power strategies. In the case of the Science Schools project, there was no tendency to cloak the power strategy in the rhetoric of problem solving and participation - which Havelock and Huberman suggest characterize educational changes in developing countries (Havelock and Huberman 1978 p.257). Power was used, willingly and openly to achieve the objective of setting up the Science Schools. It is this bluntness that probably made the strategy successful.

The use of power-coercive strategy in the Science Schools project did not also confirm the proposal by Zaltman et al (1977) that power strategies are the easiest to apply since they are based on reward and punishment. This because in the case of the Science Schools, there was no clear reward, even though the project is a policy which the opposition should have been glad to implement. There was also no punishment. An idea to set up the project was rationally, if not empirically proposed, and it was rejected. But its rejuvenation and eventual survival, on power and authority basis, rather than on conviction of the opposition clearly indicates a predominance of powerful fellowship network interactions in ensuring policy survival in Nigeria.

Indeed as openly acknowledged in the case of the Science Schools Project in Kano, the survival of the Project owes more to the presence of socio-politically powerful elements in the membership of the Board entrusted with the Schools, than a consideration of the inherent strategic merits of the Science Schools as sources of cognitive advancement of the learner, or even as instruments of social transformation. It is this powerful caucus that pushed the idea of the science schools through the Executive Council and enabled the project to gain government's approval. It is also the same caucus that saw it through its critical developmental stages.

But power and fellowship network interaction even in a combination cannot account for the relative survival, from policy perspectives, of the Science Schools Project, especially in political situations characterized by frequent changes of political leadership as in Nigeria. Three other inter-related factors emerge as contributories to the survival of the Science Schools project in the initial stages, and which are vital to understand if similar attempts to set up a project in a situation like Nigeria are to be made.

First, Kano is homogenous religiously and ethnically (Muslim, Hausa-Fulani). It shares this characteristic with only few other Nigerian States. There is no multiplicity of ethnic groups who would constitute a blockade to collective decision making and policy implementation characteristic of other multi-ethnic States in Nigeria (Kaduna State, for instance where in 1982 the Legislature virtually stood still due to internal conflicts). Consequently, decisions at Executive Council or Committee levels tend to be wholly accepted or rejected purely on the basis of either their merit, or their socio-political consequences, rather than because they do not represent or threaten the interests, of a particular ethnic sub-group.

Secondly, those in position of power and authority in Kano since the beginning of political activism in the early 1960s were part of the fellowship clique that saw the genesis of the Science Schools project. They shared the same political ideologies - ideologies which, at that time, were regarded as radical to a conservative culture such as Kano. This radicalism arising unusually within such orthodox culture provides a fertile soil for the germination of the Science Schools. Thus it is within the context of this radicalism that the emergence of an innovative concept such as the Science Secondary Schools Project can be better understood. The opposition to the project must also be interpreted within the framework of this orthodoxy.

Thirdly, there was no partisan politics at the time the Science Schools Project was initiated. If anything, it came during the tenancy of one of the more remarkable Military regimes in Nigeria (under General Murtala Muhammad), and thus the survival of the Science Schools Project can only be judged on the basis of its status as a social strategy of development, rather than political ideals characteristic of any political party which could give rise to acrimony. Partisan politics would have been an unwelcome ingredient in the mixture, since even without its presence the course of development of the project was erratic.

Yet despite these relative advantages for Kano State in Nigerian social and political setting, the implementation of the project still fell a bit short, especially in intellectual guidance. The appointment of the people "with science background" to the Science Board which guides the implementation of the project was expected to provide some intellectual legitimacy to the policy decisions behind the project, and envisaged a situation where such personnel could provide the proper intellectual input to the project.

And yet their contribution to the project was only in the sphere of socio-political influences they held in Kano State which ensured the survival of the Project. There was no evidence of any noticeable intellectual input to the Science Schools from any of the members of the Board since 1977. Or even how such "science background" in the members is expected to direct teaching and learning science in the Science Schools.

The Science Schools project was a direct consequence of economic prosperity of Kano State in 1970s. But the development of the project did not follow any specific pattern described any model of educational change. For instance, although the educational and economic situation in Kano in early 1970s lends credence to the proposal by Karabel and Halsey (1977) that educational changes reflect a revolutionary trend in society, no such revolution as envisaged in their proposal gave rise to the Science Schools project in Kano. Similarly, even in theories of "low level" change as proposed by Zaltman et al (1973), the polity model of Levin (1972) proved insufficient to explain the magnitude of social change needed to bring about the Science Schools project. The non-linear pattern of the development of the project also rules out most of the elements of the organizational change model proposed by Zaltman et al (1973). This is more so since a monitoring mechanism was not made integral to the Science Schools project, which Zaltman et al (1973) proposed as necessary in their model.

A close theoretical framework for the development of the Science Schools could have been one of the Authoritative/Participative models (Zaltman et al 1977) which characterize change in terms of the extent to which decisions are made by authority figures. In the Science Schools project, lack of dialogue involving input from teachers, parents, or even students (the Kano Students Association was quite active at the time), concentrated the decision to initiate the project with those in authority. But the framework described by this class of models requires implementors (teachers, for instance) to have an input, no matter how negligible, into the innovation. This did not happen in Kano, even though some teachers at one stage did request for professional services which will give a forum for their input into the overall direction of the project. Thus because of the nature of its development, the pattern of the Science Schools therefore leans more towards Authority Innovative Decisions dimensions of this class of models, as proposed by Rogers and Shoemaker (1971). The characteristics given for this theoretical dimension confirms the observations made about the problems of science education innovations with administrative, rather than academic origins.

The Science Schools project therefore combines elements of many models which describe educational changes, and confirms the vulnerability of a research strategy where attempts were made to explain the findings within the theoretical paradigms of a single model. Moreover, educational changes are not about models, but outcomes. And since social processes are not always linear, it becomes difficult to suggest a definite pattern of behaviour in educational change strategies. Any model that attempts to explain the process of change therefore must rely on a measure of the outcomes of the process. It is this that makes the Havelock and Huberman (1978) IAC pattern model viable as an instrument of change analysis, in some ways, which I will be looking at later.

9.3 Structural characteristics of the project

The science curriculum was seen by the planners of the project in terms of the number of subjects each student should be taught in the Science Schools. There was no forum for consideration of any special emphasis that should be given to science teaching in the schools. This is even though a basic rationale of the project was the schools were created to "emphasize science" The nature of the emphasis was never made clear.

In the classic mode of problem solving situations, the nature of the science curriculum to be taught in the Science Schools must be a major component of the merits of the Science Schools Project. This is important since the expectations of the Science Schools project were for more ambitious socially oriented outcomes, and by implication, a curriculum characterized by greater accessibility, more obvious relevance to perceived problems and increased harmony with specific cultural context. It is surprising, therefore, to note in the case of the Kano State Science Schools Project, this was not a consideration of the planners.

And this was because although the science curriculum reform movement has significant influences in the way science is perceived as an educational process in both developed and developing countries, the initiators of the Science Schools project did not reflect their awareness of the movement, so could not resort to it for pedagogic references or guidelines. And since there were no pedagogic guidelines particular to the project, the Science Schools therefore rely totally on the general Nigerian science curriculum to translate their objectives.

But an analysis of both the science curriculum taught in the Science Schools, as well as how the teachers in the schools teach it, reveals a lack of internal consistency in the curriculum, and a lack of correlation between the way the students are taught, and the emphasis in science expected by the developers of the science curriculum by the teachers. As the data suggests, science teaching in the Science Schools does not develop the students' abilities in terms of acquisition of the intellectual characteristics envisaged by the new science curriculum. It merely identifies these abilities so that those who continue with education beyond the Science Schools and go to the University, can do the sort of programmes expected of them by the progenitors of the Science Schools Project. Science education, in the Science Schools become a struggle for survival, enhanced by the selection procedure during which only the fittest moved on the higher institutions of learning. This has a considerable effect on the students reflected in their inability to distinguish between their educational and occupational aspirations and expectations; and consequently, are unaware of the role of science in social transformation and advancement.

A theoretical framework used to analyse the internal characteristics of the science curriculum in the reality of the Science Schools drew from the IAC model configurations synthesised by Havelock and Huberman (1978), and provides a wider context for considering the nature of the science curriculum used in the Science Schools. However, the findings of this research indicate some inadequacies of the model if used to analyse the outcomes of every educational change. First, the Science Schools project requires the participation of many people (teachers, administrators and students). Its science curriculum also requires materials (laboratory and equipment supplies, textbooks). Thus it is what Havelock and Huberman would call large-scale in elements (EL+).

Secondly, the science curriculum of the schools expects a considerable change of behaviour. For instance, teachers are expected to change their teaching habit and adopt a new strategy which they are not familiar with (teaching through learning-by doing). Students are also expected to learn science under new conditions which it is expected should re-orient their perception of science (thus they will think more analytically like scientists). This would mean the curriculum has a large-scale in behavioural changes (BC+).

And if the Science Schools project adopts an EL+ and BC+ pattern as it would seem to, then the status of other elements of its implementation from the overall IAC pattern is quite vital. As Havelock and Huberman argued,

> "any project which aims at both EL+ and BC+ can only succeed if it has a well developed infrastructure (I+) to process all the elements, and strong leadership or control function (A+) to be certain the users will try out the new behaviours over a sufficient duration to insure their having a chance of being durable. Ideally, these projects would have full consensus (C+), but with BC+ there are certain to be groups of people unwilling or unable to accept such a radical change in what they ask of themselves. In short, EL+ and BC+ are not likely to succeed unless there is I+ A+ C+ " (Havelock and Huberman 1978 p.85)

But the analysis of the Science Schools project and the science curriculum used in the schools shows such conditions do not exist to enable full attainment of BC+. The configuration that emerges is I- A+ and C- which reflect lack of facilities, enthusiastic, more likely, optimistic authority and general lack of agreement, in speech and in practice, among teachers to teach science the way envisaged by the curriculum developers.

Thus a fundamental problem not addressed by the new science curriculum as used in the Science Schools, and not redressed by the Science Schools was teachers in the Science Schools were either not aware of the extent of the differences between the new science curriculum and the old one, or, if they indicated actual awareness did not see how the new science curriculum personally affects their teaching. And since explicit links were not suggested between the new science curriculum and the way science is taught in the Science Schools by the Science Board (i.e. through "emphases"), or how it is expected to affect the products of the Science Schools, this leaves the science curriculum open to convenient interpretation from the teachers - which, from the evidence, yields little correlation between the objectives of the Science Schools, as can be discerned, and the new science curriculum, at least as intended by the rhetoric of its developers.

Further, a powerful political rationale of the new science curriculum has been to de-emphasize the academic nature of science education and make it more relevant to societal needs. This would seem to make the curriculum inappropriate in the fiercely competitive climate of the Science Schools whose major policy thrust was to provide a highly academic climate for studying science.

What emerges from the findings of this thesis is political rationales for educational change strategies in Nigeria provide a suitable basis for projecting beliefs about social progress, but little attention was paid to the sustenance of these change strategies, or in real terms, how they fit in with social realities. The issue facing any change strategy is not just of need, clarity, complexity or the quality of the materials used, but the constant production of personnel who identify with the rationales of the change strategy enough to see to its sustenance to achieve a reasonable measure of its objectives. That is the essence of science education as a long term service aimed at radical social transformation.

9.4 Emergent issues

In the project patterns developed out of the IAC by Havelock and Huberman it was not clear whether the patterns adopted by any innovation strategy will remain fixed for the rest of the duration of the project. This is because, as demonstrated by the genesis of the Science Schools project in Kano, due to changes in political sentiments and unstable nature of economy (both not accounted for by the project) shades of patterns fade out. The various configurations of the IAC model would therefore be inadequate in providing a descriptive framework for the understanding the mechanism of the Science Schools project.

Other omissions, although acknowledged only in the parent model, in the configurations are political and economic stability. Educational changes are not necessarily the outcome of logical conviction for a change, but the extent of power and influence of those initiating them. And the sustenance of the change thus becomes the domain of fellowship network interactions which ensures the survival of the change strategy. This is shown by the various configurations of the IAC model that emerged in the study of the Science Schools.

Moreover, economic forces under which radical or ambitious change strategies were advocated often turn out to deplete the same verve with which the strategies were started. These two other ingredients - political and economic stability - must be made fully part of any model which provides any analytical framework for educational change strategies in Nigeria. Havelock and Huberman (1978) eliminated them from their model - making it incomplete as a theoretical paradigm for analysing all categories of educational changes.

But in the case of the Science Schools project - especially in its status as small-scale science education project - another variable which was not featured in the configurations (or inadequately presented) emerges as the most significant factor in the project - the students. Too often in science educational change strategies the curriculum has been the focus of attention. Science curriculum developers have always held the conviction that radical transformation of the way science is taught and learnt by students holds the key to rapid economic prosperity.

This research has discovered it is not so much a new science curriculum or its radical learning context that makes all the difference to the outcomes change strategies in science education, but the students personal commitments to science. Within this context, social forces tied up with the value of schooling in the Nigerian society provides a further healthy catalytic base for speeding up the students identification with any science educational change strategy.

The data presented in this research did not prove the way science was taught to the students could produce the outcomes in the students the Science Schools did. Being in the schools probably helped, but it is not certain since the the selection process has ensured only an exceptionally motivated sort of student could be admitted into the schools. This is because even though direct comparisons were not made or sought between the Science and nonscience schools, the research evidence clearly shows little difference between the two categories of schools in teaching facilities, teacher strategies and students' perception of fundamental learning variables in science. Another factor then, besides the Science Schools, or possibly in conjunction with them, is largely responsible for the project outcomes expressed through the students.

9.5 Concluding Remarks

Two broad perspectives informed the analysis of these findings. The first is from an analytical point of view. The findings in this research clearly demonstrated the powerful stimuli of economic and political forces in the development of science education innovations. But in the process, it has also highlighted the fundamental problems faced when science education change initiatives are based on political, rather than academic priorities, and in the process demonstrates that in using science education for developmental purposes, administrative priorities over-ride academic considerations of the inherent values of scientific training.

And although acknowledging the political stimulus in bringing about the change, the research has shown changes in science education require a different strategic focus than those applied in general educational changes. This is because changes in science education require a marked degree of attention to be given to the cognitive outcomes of the process. As such, because of the role of scientists in social development, I am proposing that for science education policies to be effective in national development, such policies must be based on academic, rather than political considerations. The data provided in this research supports this proposal. This is more so since political priorities serving as a base rationale led to the first generation science curriculum reform activities, particularly in the US. They also led it into a winter of discontent.

The second view of the project is from policy perspective. In this dimension it has fulfilled the policy expectations of those who set up the project. It has succeeded in enabling a considerable number of science students from Kano State to proceed to institutions of higher learning and study disciplines considered necessary for social and economic advancement. And although the rate of production is small but steadily increasing, policy planners of the project envisaged a decade from now (1988-1998) Kano State will satisfy its scientific and technical manpower requirements, and indeed may have surplus manpower in these disciplines. But taking into consideration the nature of resistance to general western style of education in Kano, the Science Schools project represent some remarkable policy achievement in the development of education in Kano State.

But an unforeseen problem is associated with this. Education cannot be isolated from economic development. The Science Schools are in the danger of producing a large supply of highly qualified manpower which may not be utilized (or employed) because social development has not kept pace with their production. But in effect, this has always characterized science education changes. Policy makers wishing to bring about rapid social transformation through science education rarely pay adequate attention to the provision of context facilities where the products of the process can be adequately absorbed in the society.

So far science education changes have provided little avenue for a consideration of the integration of the product of the changes into their predominant societies. This might be because such changes as envisaged by the science education changes are not as explicit as in the Science Schools project. Thus a rethink on the impact of science education policies, in consistence with economic development would seem to be in order.

The findings in this research are significant in that developing countries rely on administrative initiative for curricular reform. And if a practice is established where administrative priorities over-ride academic considerations, then attainment of development goals through science education become susceptible to the instability of economic and political forces prevalent in developing countries. This will have a retarding effect on national development goals. Kano, as one policy maker remarked, is lucky with regards to the Science Schools project. A more rational process than luck ought to be the motor of social development.

9.6 Areas for further research

The following points are raised as areas where further research in a better utilization of science education programmes for national development might be needed to extend the phenomena of the Science Schools.

1. The impact of the products of the Science Schools on the labour market, especially those who enter the labour market immediately after leaving the schools need to be measured to determine the extent of their productivity in the labour market. This should provide a basis for linking the products of the Science Schools with labour market productivity, and thus maximize their contribution to social development.
2. The true effect of the Science Schools on the development of attitudes to science and career expectations need to be determined. It is not enough to conclude positive attitudes and high career expectations exist among the students in the Science Schools; they should anyway. But to what extent can such attitudes be attributed to the Science Schools? Also to what extent can the achievement of the students be attributed to the Science Schools? This is important because if other factors beside being in the Science Schools are identified as the essential components of developing positive attitudes to science and science related occupations, then attempts can be made to isolate them and develop them in the majority of students who wish to study science but cannot do so in the province of the Science

Schools. It should increase the output of the science oriented graduates from Kano State as a whole.

3. There is also a need to explore fully the students' difficulties in learning variable in science. This should enable determining whether any learning difficulties in a group of highly motivated and expectedly high ability students is caused by the intrinsic nature of the science curriculum, or the teaching strategies adopted by the teachers.
4. Strategies for making teachers identify with the basic rationale and objectives of the Science Schools project need to be developed. This should enable teachers develop specific emphases in their teaching consistent with the overall objectives of the Science Schools, even though significant policy rationale behind the project were not part of the implementation package.
5. In connection to this, what should the Science Schools emphasize in their teaching to the students? This should be informed by a consideration of the long term economic realities of Kano State; this should enable the products of the Science Schools to fit in with the economy, and should provide a ready basis for an advanced training for those able to proceed with their education. This is also important because it ensures a relationship between the emphases and outcomes of the Science Schools and Kano State economy. This should avoid creating situations where there is an over-concentration of manpower in certain areas for which Kano State has either no need or cannot support because of the operational demands of the discipline.
6. Finally, the effect of the Science Schools project on the general educational system in Kano State needs to be determined. This should reveal whether the organizational procedures in the establishment of the Science Schools can be generalized to development of other subject disciplines, and the extent to which the outcomes of the Science Schools project affect educational practices and convention in Kano State.

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Appendix I

Scheme For Analysing The New Nigerian Science Curriculum

The analysis of the curriculum materials carried out for this research attempts to identify the most fundamental characteristics of the Nigerian Science Curriculum. According to Eraut et al (1975) there are three specific functions of an analysis. First, a descriptive function which aims at describing the materials and their rationale and structure. Second, an evaluative function which enables judgements to be made about the materials against a range of criteria irrespective of the context in which they are to be used. Third, a decision making function which is context specific and advisory in terms of selection or implementation of decisions.

The analysis of the science curriculum materials carried out in this research uses the same rationale. It seeks to determine the intended aims of the producer, as well as the extent of the consistency of the science curriculum materials used in the Science Schools. But because in Nigeria the term "curriculum" was used to refer to the syllabuses of Biology, Chemistry and Physics only, the analysis was necessarily restricted to these materials; consequently, the three analytical functions are not fully developed in the analysis. The analysis was further made difficult by lack of any textbooks to accompany the curriculum when it was introduced in Senior Secondary Schools in September 1985. In this context therefore, any analytical scheme used is limited by lack of the text materials.

And because the production of textbooks did not accompany the launching of the new educational policy in 1985, uncertainties were created in the minds of teachers and school authorities regarding the status of any book coming quite a while after the adoption of the curriculum in schools. This is because although making the schools to adopt the new policy is a legislative act of the Nigerian Federal government, such strategies rarely - probably because they cannot be made to - extend to insisting on the books the schools should use for any new educational policy.

And unless there are new textbooks sharing the same philosophy as the new science curriculum, the problems the new curriculum sets out to solve may remain for quite a while, and may indeed become amplified. This, however, did not prevent enterprising publishers from suddenly producing 'new editions' of the same old books to garner the expectation of a growing demand.

This is illustrated by the appearance of a 'New Edition' of "New Biology for West African Schools, 2nd Edition, by R.H. Stone, A. Cozens and F.O.C. Ndu. This book has existed in one form or another for almost fifteen years in Nigeria. Its fifteenth impression was published in 1981. In 1985 the "New Edition" claiming to satisfy the needs of the new science curriculum appeared in the Nigerian market in time for the implementation of the new science curriculum in the country. In the absence of specified books to go with the new science curriculum, a detailed analysis of these "new editions" would therefore be necessary to determine if the messages of the new science curriculum are actually carried in them. However, this was not attempted in this research.

The analysis of the materials was carried out using an adaptation of an analytical scheme developed by West (1975) at the University of Sussex. This was found suitable because the West scheme was developed to carry out a summative evaluation of a curriculum (the Nuffield Chemistry Project, see West 1974) whose stated aims and suggested strategies were quite similar to those stated in the Nigerian science curriculum materials.

The summary of original scheme used by West is reproduced below (West 1975 p.29).

Section 1	A description of course materials
1.1	Materials for the teacher
1.2	Materials for the pupils
1.3	Other support materials
Section 2	Antecedent Conditions
2.1	Pupil Age and Ability range
2.2	Previous Knowledge and experience of pupils
2.3	Organization of teaching group
2.4	Teacher capabilities and requirements
2.5	Curricular implications
2.6	Financial and Resource implications
Section 3	Rationale and Strategy
3.1	General Rationale
3.2	Aims and objectives of the course
3.3	Teaching and learning mode
3.4	Course content
3.5	Teaching and learning strategy
3.6	Internal and External assessment
Section 4	Intrinsic Evaluation
4.1	The organization of the course content
4.2	The relationship between content, techniques, principles and processes
4.3	Teaching modes and interactions
4.4	Homework assignments
4.5	Outcomes of alternative teaching strategies
Section 5	Summary and Implications
5.1	General summary of Section 1 - 4
5.2	Implications for the performance evaluation
5.3	Implications for the context evaluation

In the absence of other materials besides the syllabus guidelines, the adaptation of the scheme was not so much in the structure of the scheme as in its depth and emphasis. In this research, the scheme was accompanied by observations of pattern of use of the syllabus guidelines in the classrooms during the field work. The scheme eventually used in this research is reproduced below and frames Chapter 6 of this thesis.

Section I: Background History Of The New Nigerian Science Curriculum: This contains background information about the origin of the science curriculum in Nigeria.

a) Genesis of the Curriculum
b) The new National Policy on Education
c) Description of the Curriculum
d) The Text materials for the new curriculum

Section II: Rationale And Curriculum Strategies: This contains an analysis of the rationale and strategies assumed by the curriculum. This seeks to determine why the curriculum was developed, the nature and organization of the curriculum context; the explicit aims and objectives of the curriculum and the proposed teaching and learning strategies. The sub-categories of the section are:

a) General Rationale
b) Aims and Objectives
c) Teaching and Learning Mode
d) Curricular Content
e) Internal and External Assessment

Section III: Antecedent Conditions: An analysis of the antecedent conditions implied by the curriculum. This deals with the assumptions made about the pupils and the teachers, and the organizational context within which the curriculum can be implemented. The sub-sections are:

a) Pupils Ability Range
b) Previous Knowledge and Experience
c) Organization of Teaching Groups
d) Teacher capabilities and requirements
e) Financial and Resource Implications
f) Curricular Implications

Section IV: Intrinsic Analysis: An intrinsic analysis of the curriculum to determine the extent of internal consistency between its objectives, contents and methods. This is done through a consideration of

a) General aims and performance objectives
b) Emphasis on Content, Techniques and Principles: The subjects
c) Emphasis on Content, Techniques and Principles: The Years
d) Section Analysis: Genetics
e) Correlation between Aims and Performance Objectives
f) Aims for Science Education

Section V: Summary and Analysis of Findings: A summary of major points raised by the analysis and implications for the Science Schools Project in Kano State. A link is also established between the findings of the analysis and the general theories of educational change strategies.

The analysis of the curriculum materials was quite straight forward and the process itself did not pose any problems. However, as stated earlier lack of actual text materials posed limitations to any generalizations that could be made as a result of the curriculum materials analysis in this thesis.

To provide a clearer idea of the science curriculum, the conceptual schemes given in the Biology and Physics reproduced below. Chemistry does not have any in the copy I have.

Appendix II

Methodological Notes On School Observations

A significant concern of this research has been to determine the nature of the various interactions between the students and the teachers in the Science and the nonscience schools, although with greater emphasis in the former category of schools.

The main objective of carrying out the classroom observations has been to to determine the teaching emphasis and strategies of the teachers in the Science Schools. Four schools were observed; two Science Schools (Dawakin Tofa and Taura) and two nonscience schools (Gwale and Rumfa; both of which are located in Kano city). Other schools (see Appendix 3) provided further background information (through informal school observations, documents, interviews with teachers and principals and questionnaires given to students) which contributed to an understanding of the way both the Science and the nonscience schools were administered and how science subjects are taught in Kano State secondary schools.

The Science Secondary Schools Observations

The choice of which Science Schools to observe for the research was guided by a strategic need to select one school out of the pioneer science schools (Dawakin Tofa), and one out of the newer ones (Taura) which would provide a picture of the project as it was then at genesis (1977), and as it is at the time of this research (1986). The nonscience schools were chosen because each was well established and any problems of teaching and learning could not therefore be attributed to getting started. However, because the scope of this research did not include comparative aspects, no direct attempts were made to compare the two categories of schools. The main objective of including the nonscience schools in the research has been to gain an insight into the nature of conventional science education in Kano State.

The school and classroom observations themselves were quite straight forward. Access to the schools documents, the students and the teachers was easy to negotiate. I had the full co-operation of the teachers and the authorities.

This is more so since the authorities of both the schools and the Science Board clearly have a personal stake in the Science Schools and their images. In essence, my research was seen as an opportunity to polish and further sell the conception of the Science Schools as an educational policy through a systematized medium (the research process) to a larger audience. Thus in interviews officials were eager to emphasize certain aspects of the Science Schools project, but equally eager to ignore others. A few of the teachers, already quite bitter with the Science Board on personal grounds of non-fulfillment of rights and entitlements, were in turn eager to highlight what was ignored by the Science Board, and quite eager to rationalize their practices and procedures in classrooms. These two - teachers and officials - provided some unexpected triangulatory checks on each other.

The Development of the Observation Schedule

Although the eventual schedule used in this research is independent, nevertheless the works of Eggleston et al (1976) but more particularly Alexander et (1974) were consulted and provided useful guidelines in its structure.

Moreover, an analysis of the Nigerian science curriculum also provided a wide range of variables which formed a framework around which an observation schedule could be structured, especially if the observation set out to determine the extent of the relationships between the curriculum developers intentions and its teaching in classrooms. This makes it possible to clarify the categories of behaviours expected during the teaching of science in the schools. But it must be emphasized here the development and subsequent use of the schedule used in this research was limited by lack of other curriculum materials. What I observed, therefore, were classroom interpretations of syllabus guidelines, rather than interactions of teachers and pupils with a single set of comprehensive curriculum materials.

In the first version Schedule, the term "activity" is used frequently. This is because the analysis the new Nigerian science curriculum reveals the curriculum developers are of the view science teaching in Nigeria should center around what is called "activity". This was designed to reduce situations where a teacher presents the lessons first, and later takes the students to the laboratory for a practical session on the lesson - a strategy which the new science curriculum developers believed was quite predominant in the way science taught in Nigeria before the advent of the new science curriculum in September 1985.

The Observation Schedule - Mark I (September 1986)

1. Settling Down/Administration

2. Teacher Talks and
   a) introduces facts or principles
   b) asks questions on the lesson
   c) explains facts or principles
   d) expands explanation of facts or principles

3) Teacher Introduces Activity
   a) describes activity/gives instructions for activity
   b) explains purpose of activity and procedure
   c) refers students to printed material about activity

4) Class-Teacher Activity
   a) teacher demonstrates specified activity
   b) teacher observes students setting up materials for activity

5) Group of Students carry out Activity
   a) set up the equipment for activity
   b) carry out activity
   c) refer to printed materials during activity
   d) consult teacher during activity
   e) refer to each other during activity
   f) students write up results of activity
   g) students tidy up work stations/laboratory after activity

6) Class-Teacher Discussion
   a) each student report to group results
   b) students question each others' results
   c) students make inferences and deductions about results

d) discuss each others' inferences and deductions
e) group and teacher consider results and discuss
f) teacher asks questions to test performance objectives
g) teacher concludes by re-stating fact or principle.

The Observation Schedule - Mark II (October 1986)
In trying out the Mark I version of the Observation Schedule in September 1986), it rapidly became clear the schedule was too optimistic about teaching science in Kano State Secondary Schools. If the schedule were to be used to classify the classroom activities, then many of its variables will be totally blank. Science teaching was still carried out along the lines of the traditional curriculum, i.e. in a non-activity mode, with the teacher giving out a lesson and later taking the students to the laboratory for practicals.

This necessitated the development of a Mark II observation schedule which not only takes into consideration the broad expectations of the Nigerian science curriculum, but also more or less adapts itself to predominant features of science teaching strategies in Kano State classrooms, and at the same time enables judgements to be made about the interpretation of the new science curriculum by the teaching patterns exhibited by the teachers. The Mark II schedule is based on the same category system of classification as Mark I, and its basic structure is as follows:

1. Settling Down
2. Teacher Talks and
   introduces topic
   reviews topic
   expands explanation of topic
3. Students ask questions
4. Teacher ask questions
5. Teacher refers to text
6. Teacher writes on board for students to copy
7. Teacher demonstrates activity
8. Students carry out activity
9. Class discussion of activity

However, the schedule includes facilities where full information on timing for each category of behaviour can be collected during the observations, and this is given in Table II.1. The schedule is also split to reflect the pattern of teaching in each of the two subjects observed (in this case Biology and Physics).

Table II.1 Teaching Biology And Physics Science and Nonscience Schools By Frequency of Observation And Time Spent

	Number of 5 Min Durations per Category					
Category	**Biol.**	**%**	**Phy.**	**%**	**Total**	**%**
1. Settling Down						
2. Teacher Talks and						
introduces topic						

reviews topic						
expands explanation of topic						
3. Students ask questions						
4. Teacher ask questions						
5. Teacher refers to text						
6. Teacher writes on board for students to copy						
7. Teacher demonstratesactivity						
8. Students carry outactivity						
9. Class discussion ofactivity 0						
Total Number Of Periods						
Observation Time (Mins)						

The Schedule of Observations And Analysis

Lessons in the Science Schools last for 40 minutes, although all the science lessons were which meant 80 minutes for each lesson. I restricted my observations only to SS2 classes which were the most senior classes in the scheme of the New National Policy on Education at the time (1986/87) and correspond to Form 4 of the former system. I could not observe SS3 classes since there were none at the time of the field work, and SS1 classes were too new to provide a definite pattern of science teaching in the schools. Not all my classroom observations were recorded. When I arrived in the schools to start the field work in September 1986, I spent about three weeks getting my bearings and trying out my observation schedule. Table II.2 shows the number of lessons observed in the Science Schools as well as the dates and times of the observations

Table II.2: Summary Of Classroom Observations in Science Schools, October 1986 To March 1987

School	Date	Subject	Time	Total
D/Tofa	27.10.86	Physics	11.10-12.30	80
D/Tofa	29.10.86	Biology	11.10-12.30	80
D/Tofa	30.10.86	Physics	8.50-10.10	80
D/Tofa	30.10.86	Biology	11.10-12.30	80
D/Tofa	26.01.87	Physics	11.30-12.50	80
D/Tofa	26.01.87	Physics	12.50- 2.10	80
D/Tofa	28.01.87	Biology	11.30-12.50	80
D/Tofa	28.01.87	Biology	12.50- 2.10	80
D/Tofa	23.02.87	Physics	11.30-12.50	80
D/Tofa	25.02.87	Biology	11.30-12.50	80
D/Tofa	23.03.87	Physics	11.30-12.50	80
Taura	3.11.86	Physics	8.50-10.10	80
Taura	3.11.86	Biology	10.50-12.10	80
Taura	3.11.86	Physics	12.20- 1.40	80
Taura	7.11.86	Physics	10.50-12.10	80
Taura	7.11.86	Biology	12.20- 1.00	40
Taura	11.02.87	Physics	10.50-12.10	80
Totals	17 Recorded Lessons			1320

The table indicated only those lessons which were actually recorded in my schedule and which formed the basis of my analysis. The total number of teachers I observed in the Science Schools, and subsequently discussed various issues with was seven. These were 3 Biology and 4 Physics teachers who handled SS2 classes. All the four teachers I observed in Dawakin Tofa were Nigerians. Of the three teachers I observed in Taura, only one (Physics) was an expatriate Asian. The other two were Nigerians.

The recordings here excluded the preliminary and confirmatory visits which were done at the beginning of the field work (September 1986) and after a considerable amount of data were collected (March 1987). They also exclude visits to the schools for the purposes of interviews with officials and teachers. I recorded 17 individual lessons out of 22. There were quite a few occasions in which I found nothing to record in my schedule except the time spent on each task on the schedule by the teachers or students.

My initial plan was to observe two schools per week in rotation until the end of the field work period (March 1987). However, I discovered after the first three weeks (from 23rd September 1986) I would get more depth out of the observations if I concentrated on one school at time for a whole week.

My research and subsequent presence in the schools were both explained by the Principals to their Heads of Departments, who in turn informed the teachers (some of whom were already aware of the research from previous contacts). On reporting to a class I usually sat at the back and stayed until the end of the period (80 minutes or more). I tried to remain as unobtrusive as possible, and there was no single instance in which I uttered a single word during any lesson. My role there was an observer, not a participant.

The schedule was based on a category system of classification. This lists a category for events, each being recorded each time it occurred during the observation period. Each category of events is placed in a five minute cell and is noted the moment the teacher started exhibiting that behaviour. Often two categories were exhibited by the teacher at the same time, and each is recorded separately.

The behaviour in the category was recorded for each five minute period throughout the entire duration of the lesson. Because of the drawn out nature of teaching in the schools, often the category of behaviour being recorded exceeded five minutes; in which case it is allocated into the next time cell. At the end of the lesson it was possible to determine how many minutes were spent on each category of behaviours by counting the frequency of occurrance, and multiplying each by five (minutes). This enables a calculation of the percentage time spent on each category at the end of the entire observation period.

My observations were not restricted only to the classrooms. Other impressions of the Science Schools were obtained as a result of going over the school itself and inspecting the laboratories and the equipment provisions in each laboratory. Many formal (recorded) and informal (not recorded) discussions took place between me and the teachers and school authorities. The observation schedule therefore represents only one aspect of the classroom observations. It is not complete in itself, and in Chapter 7 various data concerning classroom dialogues between teachers and students were incorporated into building up a picture of the teaching and learning process in the Science and the nonscience schools.

The Nonscience Secondary Schools Observations

Observations in the nonscience schools were less extensive than in the Science Schools, for the obvious reason that my focus was the Science Schools, although the same schedule and observation techniques as in the Science Schools were used. But the observations in the nonscience schools were much more difficult. This was because right from the time I was introduced to the 3 Physics and 5 Biology teachers I observed (seven Asian expatriates, and one Nigerian) many attempts were made to neutralize any possible faults I could find in their teaching. These were mainly in the form of many complaints about the science teaching facilities in the schools. Table II.3 shows the dates, and times the observations took place and the number of the lessons observed.

Table II.3: Summary of Classroom Observations in Nonscience Schools, October 1986 to March 1987

School	Date	Subjet	Time	Total
Rumfa	12.11.86	Physics	9.20-10.40	80
Rumfa	12.11.86	Physics	11.10-11.50	40
Rumfa	17.11.86	Biology	9.20-11.40	80
Rumfa	18.11.86	Biology	11.10-12.20	70
Rumfa	19.02.86	Physics	9.20-10.40	80
Rumfa	18.02.87	Physics	11.10-12.20	70
Gwale	22.10.86	Physics	8.40 -9.50	70
Gwale	22.10.86	Biology	12.45- 1.25	40
Gwale	10.11.86	Biology	11.10-12.20	70
Gwale	11.11.86	Physics	8.00- 9.10	70
Gwale	20.11.86	Biology	11.00-12.25	70
Totals	11 Recorded Observations			**740**

Another reason why observations in the nonscience schools were not so extensive was the closure of all male post primary schools in Kano metropolitan area on Sunday 15th March 1987 by the Kano State government, because of anticipated student unrest, although by then I had started thinking about winding up the field work. The closure coincided with the time I had planned to continue further observations of the nonscience schools after a rather lengthy period of absence.

Further difficulties were imposed on the observations in the nonscience schools by sudden changes in time-tabling arrangements. After the initial period of my observations, often teachers I came to observe change the periods when I came to observe them; although there were offers of "arranging lessons" for me to observe, which I declined. Table II.4 summarizes the observation period in all the four schools I observed.

Table II.4: Summary of Classroom Observations in Science and Nonscience Schools, October 1986 to March 1987

School	Date	Subject	Time	Total
Gwale	22.10.86	Physics	8.40-9.50	70
Gwale	22.10.86	Biology	12.45- 1.20	35
D/Tofa	27.10.86	Physics	11.10-12.30	80
D/Tofa	29.10.86	Biology	11.10-12.30	80
D/Tofa	30.10.86	Physics	8.50-10.10	80
D/Tofa	30.10.86	Biology	11.10-12.30	80
Taura	3.11.86	Physics	8.50-10.10	80
Taura	3.11.86	Biology	10.50-12.10	80
Taura	3.11.86	Physics	12.20- 1.40	80
Taura	7.11.86	Physics	10.50-12.10	80
Taura	7.11.86	Biology	12.20- 1.00	40
Gwale	10.11.86	Biology	11.10-12.20	70
Gwale	11.11.86	Physics	8.00- 9.10	70
Rumfa	12.11.86	Physics	9.20-10.40	80
Rumfa	12.11.86	Physics	11.10-11.45	35
Rumfa	17.11.86	Biology	9.20-11.40	80
Rumfa	18.11.86	Biology	11.10-12.20	70
Gwale	20.11.86	Biology	11.00-12.25	70
D/Tofa	26.01.87	Physics	11.30-12.50	80
D/Tofa	26.01.87	Physics	12.50- 2.10	80
D/Tofa	28.01.87	Biology	11.30-12.50	80
D/Tofa	28.01.87	Biology	12.50- 2.10	80
Taura	11.02.87	Physics	10.50-12.10	80
Rumfa	18.02.87	Physics	11.10-12.20	70
Rumfa	19.02.86	Physics	9.20-10.40	80
D/Tofa	23.02.87	Physics	11.30-12.50	80
D/Tofa	25.02.87	Biology	11.30-12.50	80
D/Tofa	23.03.87	Physics	11.30-12.50	80
Totals	**28 Recorded Observations**			**2060**

As explained in Chapter 7, in one of the Science Schools (Dawakin Tofa), I discovered there were often two of us carrying out an observation of a teacher; the other being the teacher's Head of Department. The HOD also uses an observation schedule designed by the school. I was able to obtain a copy of this schedule and it is reproduced here. As explained in the text, the results of the observations are used as part of the criteria in promoting or renewing a teacher's contract. According to the school authorities, it provides a satisfactory impression of the quality of the lessons conducted in the schools.

Other schools do not seem to have a structured observation schedule with the same purpose as the one used in Dawakin Tofa Science School. In Taura Girls Science Schools, for instance, the school authorities explain they "often drop" by selected classes to make sure all teachers were in their classes. This is similar to the observation strategy also used in the nonscience schools where no specific observation schedule is used.

DAWAKIN TOFA TEACHER OBSERVATION SCHEDULE.

Appendix III

The Students Attitude Questionnaire

In order to determine the attitude of the students in the Science and nonscience schools towards science and scientific careers, an attitude questionnaire with 56 items was designed.

Eight schools were identified for the distribution of the questionnaires, some of which were also used for school and classroom observations. Four of the source schools were the Science Schools at Dawakin Tofa (1977), Dawakin Kudu (1977), Kafin Hausa (1985), all for boys, and Taura (1981) for girls. The four nonscience schools were Rumfa College (1927), Gwale Secondary School (1968), Government Girls College, Dala (1961), and Government College Birnin Kudu (1961).

The questionnaires were given to 530 SS2 students - 320 in four of the Science Schools (D/Kudu, D/Tofa, K/Hausa and Taura) and 210 in four nonscience schools (Dala, Rumfa, Gwale and B/Kudu). A total of 500 questionnaires were returned - 300 from the Science Schools and 200 from the nonscience schools. The questionnaire distribution in all the seven schools was done by the teachers under my supervision and instructions. In all cases it became necessary to include the teachers because the school authorities do not wish the students' lesson routines to be disturbed, especially in the Science Schools. So the questionnaires were given during evening prep periods in the Science Schools and the nonscience Girls Secondary School (Government Girls College, Dala), while in the other two nonscience schools (Gwale Secondary School and Rumfa College), questionnaire distribution was done during a break period.

In each case of questionnaire distribution I had to explain to the teacher what the items were, and no problems were reported back to me concerning the distribution or answering. As far as I could tell, sampling was quite random - indeed so random that it did not follow any specific order. In each case the teacher simply goes down the class and hands out the questionnaire to the students.

All the questionnaire items were written in what I consider simple English. Any ambiguity was sorted out from the returns of the trial sample given to students in Kano and Borno States in June 1986 before the final questionnaire was written. No attempts therefore were made to translate any item into Hausa language. The questionnaire was distributed and collected back during the field work period. I also did all the coding while on the field work site.

The questionnaire is divided into two sections. Most of the items in Section I are free response which sought personal information about the students including career aspirations. Section II has greater attitudinal emphasis with 36 items divided into three broad dimensions: personal response to science, perceptions of science in society and attitudes to science subjects and experiments. This section has five scales of opinion responses and the respondent was required to answer only one scale. The questionnaire is reproduced below.

Attitude Questionnaire

SECTION 1

1. Name-------------
2. Age---------------
3. School------------
4. Class-------------
5. What is the name of your town or village--------------
6. What is your father's occupation----------------------
7. What is your mother's occupation----------------------
8. What is your father's educational qualification---------
9. What is your mother's educational qualification---------
10. What is your Religion?------------

THE CLASSROOM

11. List all the subjects you study:

1.----------- 2.--------------. 3-----------------
4.----------- 5 --------------. 6-----------------
7.----------- 8.--------------. 9-----------------

12. List the THREE you like best:

1.----------------------
2.----------------------
3.----------------------

13. List the THREE you dislike most

1. -----------------------
2. -----------------------
3. ------------------------

List THREE subjects you find EASY

1. -----------------------
2. -----------------------
3. ------------------------

List THREE subjects you find DIFFICULT

1. -----------------------
2. -----------------------
3. ------------------------

14. What was your overall position in the last term's examination?

Number--------------------

15. What would you like to do when you leave school?

Could you briefly describe what you think the job involves?

----

16. But if you don't do this, what do you think you will actually do? –

----

17. What part of your science lessons do you find most DIFFICULT to understand? (TICK THOSE APPLICABLE)

- homework
- practical experiments
- lessons in the class
- calculations

18. What part of your science lessons do you find most EASY to understand? (TICK THOSE APPLICABLE)

- homework
- practical experiments
- lessons in the class
- calculations

19. If you don't understand a part of a lesson do you:

- ask the teacher for explanation
- ask your friend whom you think understands
- look up the explanation yourself in a book
- ask your parents
- forget the lesson

20. How much further do you think you will study before getting a job?

- College of Advanced Studies only
- Polytechnic
- University

THE ATTITUDES

Instruction: Read each of the statements below very carefully. Then read the choice of answers below each statement. Choose the answer you fell is right and tick it.

For example, if you DISAGREE that SCIENCE IS INTERESTING, (item Number 1) then tick the box DISAGREE in the box next to it as shown below:

Strongly Agree /--/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /X/

SECTION II: GENERAL ATTITUDES TO SCIENCE

1. Science is interesting (SCI)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

2. If I become a scientist, people will respect my views a lot (RESP)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

3. I will encourage all my brothers and sisters to study science (RELA)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

4. I find science rather boring (BOR)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

5. Kano State should train more scientists than it has now (KANO)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

6. It is my mother who encouraged me to study science (MOTH)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

7. I make friends with only science students at home (FRI)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

8. Studying science helps me ask questions about nature (CUR)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

9. Studying science will help me get a job more than studying other subjects (JOB)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

10. We should have less science lessons than we have now (LESCI)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

11. I find science subjects rather easy (EASY)

Strongly Agree /---/

Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

12. It is my father who made me study science (FATH)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

SECTION III: ATTITUDES TO SCIENCE IN SOCIETY

13. Science help make the world a better place to live (BET)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

14. Scientists should be given higher salaries by government than nonscientists (SAL)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

15. Science is responsible for war (WAR)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

16. Science is against my culture (CULT)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

17. I want to become a scientist to help my country (PATR)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

18. Science should be made compulsory for every student in Kano (COMP)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

19. Women are capable of becoming good scientists like Men (WOM)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

20. People in villages are more scientific than people in the towns (VILL)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

21. Scholarships should be given only for studying sciences not arts (SCHL)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

22. Traditional ways of doing things are better than scientific (TRAD)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

23. The government should spend less money on scientific work (LESS)

Strongly Agree /---/
Agree /---/

Not Sure /---/
Disagree /---/
Strongly Disagree /---/

24. The government should discourage studying science (DISCS)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

SECTION IV: ATTITUDES TO SCIENCE EDUCATION IN SCHOOLS

25. I enjoy Chemistry so much I look forward to it (CHE)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

26. Our teacher discourages us from experiments on our own (EXPTS)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

27. We are allowed to discuss freely during science lessons with our teacher (DISS)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

28. Biology lessons are the best to me (BIO)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

29. I think we should spend more time on experiments than lessons (MOREX)

Strongly Agree /---/

Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

30. Demonstrations by the teacher are better than doing experiments myself (DEMOS)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

31. Of all the science subjects, Physics is the best for me (PHYI)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

32. Our science teachers make us learn everything by doing it ourselves (HEUR)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

33. I will understand science lessons better if they are taught in Hausa (HAU)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

34. I like doing experiments more than listening to lessons (LIKEXP)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

35. A good science teacher makes you do lots of experiments (TEA)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

36. Our teachers discourage us from studying science (TEADI)

Strongly Agree /---/
Agree /---/
Not Sure /---/
Disagree /---/
Strongly Disagree /---/

Statistical Analysis And Interpretation

The statistical treatment of all the items is through the SPSS-X statistical package. The statistical procedures used depends on the section of the questionnaire. In Section I frequency counts and mult-response facilities were used to analyse the responses.

In section II of the questionnaire, all the times were grouped according to three dimensions which placed together items with similar meanings, and crosstabulations were used to determine the pattern of the responses. The attitudinal items (Section II) were coded for analysis with Strongly Agree given 1, Agree 2, Not Sure 3, Disagree 4, and Strongly Disagree 5. In cases where negative variables are stated, the scoring for the variable is reversed. A limitation of the questionnaire is that no tests of validity or reliability were carried out on the items, besides the trial samples given. For this reason, this questionnaire, especially the attitudinal section, does not claim to be universal.

The statements in the clusters of variables were derived as a result of reviewing similar works by other researchers. This provided a bank of 80 item statements reflecting diverse attitudes towards science. This bank was then reduced to 36 and divided, although not proportionately, into the three dimensions already mentioned.

The chi-squared test of significance was invoked, especially with the crosstabulations facility for all attitudinal items. But this was referred to in the thesis only in cases where differences between groups are emphasized, otherwise no mention was made of the test. This was because of two reasons. First the small number of respondents in the girls Science Schools (less than 50) makes intra-group comparisons (between boys and girls in the Science Schools) superfluous, and limits the extent to which the chi-squared test of significance can be judiciously used. Secondly, because no inter-group differences (between Science and nonscience school students) were sought no statistical differences in their responses are emphasized. However, I have used the statistical test of significance here to indicate possible trends if a larger sample were to be used in a subsequent follow up research.

The interpretation of the data was based on an examination of the distribution of the responses, and in all cases, the most direct interpretation is given. Information provided by the questionnaire responses is incorporated in the thesis. The series of Tables that follow summarize the statistical results. The words under the variables column summarize an entire variable, and reference should be made to the questionnaire above. All the variables are listed as in the questionnaire.

Table III.1: Attitudes To Science Among Male And Female Science School Students In Kano State: Summary Of Crosstabs Scores

Variable	Boys	Girls	Chi	Sig	Kendal	Sig
1 Sci	249	45	2.134	0.711	-0.075	0.095
2 Resp	248	45	7.711	0.102	-0.134	0.006
3 Rela	249	45	10.722	0.029	-0.082	0.071
4 Kano	253	45	5.376	0.250	-0.067	0.114
5 Moth	251	47	5.607	0.230	-0.120	0.010
6 Bor	245	43	4.781	0.310	0.036	0.258
7 Lesci	242	42	3.111	0.539	0.062	0.126
8 War	251	45	5.687	0.223	0.096	0.031
9 Less	251	47	6.090	0.192	0.061	0.132
10 Discs	251	45	6.978	0.137	-0.076	0.085
11 Fri	252	47	10.759	0.029	-0.004	0.464
12 Cur	252	47	6.432	0.169	-0.016	0.387
13 Job	243	43	5.702	0.222	-0.123	0.014
14 Easy	241	43	2.283	0.683	0.029	0.296
15 Fath	243	43	8.966	0.061	0.151	0.002
16 Bet	252	46	1.265	0.867	0.006	0.456
17 Sal	251	47	5.690	0.222	-0.107	0.023
18 Cult	252	46	33.256	0.000	0.246	0.000
19 Patr	252	46	1.804	0.771	-0.052	0.181
20 Comp	252	46	8.658	0.070	0.004	0.466
21 Wom	249	46	53.022	0.000	-0.328	0.000
22 Vill	252	46	6.018	0.198	0.038	0.238
23 Schl	251	47	10.630	0.031	0.010	0.423
24 Trad	250	47	5.786	0.215	-0.075	0.082
25 Che	250	46	23.385	0.000	-0.260	0.000
26 Expts	250	45	2.732	0.603	0.015	0.386
27 Diss	250	46	14.679	0.005	-0.173	0.000
28 Bio	249	46	3.143	0.534	-0.082	0.062
29 Morex	250	44	1.104	0.893	0.051	0.169
30 Demos	249	44	4.820	0.306	0.026	0.307
31 Phyi	250	44	9.885	0.019	0.110	0.021
32 Heur	248	44	20.842	0.000	-0.155	0.001
33 Hau	245	42	32.162	0.000	0.292	0.000
34 Likexp	242	43	2.563	0.633	-0.073	0.086
35 Tea	241	43	4.745	0.314	-0.101	0.037
36 Teadi	244	43	6.400	0.171	0.107	0.030

Table III.2: Attitudes To Science Among Science School (N=300) And Nonscience School Students (N=200) In Kano State: Summary of Crosstabs Scores

Variable	SS	NS	Chi	Sig	Kendal	Sig
1 Sci	294	199	21.481	0.003	0.178	0.000
2 Resp	293	198	9.395	0.051	0.011	0.389
3 Rela	294	199	3.316	0.506	0.067	0.060
4 Kano	298	198	12.277	0.015	0.065	0.064
5 Moth	298	198	22.595	0.000	0.169	0.000
6 Bor	288	195	2.385	0.665	-0.017	0.343
7 Lesci	284	197	9.283	0.054	-0.063	0.065
8 War	296	195	14.230	0.006	-0.026	0.259
9 Less	298	199	18.551	0.001	-0.173	0.000
10 Discs	296	199	5.263	0.261	-0.072	0.046
11 Fri	299	198	13.732	0.008	-0.071	0.041
12 Cur	299	199	4.865	0.301	0.030	0.245
13 Job	286	198	13.101	0.010	0.041	0.162
14 Easy	284	194	1.783	0.775	0.045	0.139
15 Fath	286	197	32.817	0.000	0.200	0.000
16 Bet	298	199	11.566	0.020	-0.008	0.421
17 Sal	298	199	7.863	0.096	0.037	0.185
18 Cult	298	198	13.004	0.011	0.089	0.014
19 Patr	298	198	6.013	0.198	0.060	0.086
20 Comp	298	198	11.309	0.023	0.103	0.005
21 Wom	295	198	10.314	0.035	-0.062	0.067
22 Vill	298	196	4.272	0.370	-0.053	0.099
23 Schl	298	199	8.527	0.074	0.043	0.142
24 Trad	297	199	3.824	0.430	-0.067	0.053
25 Che	296	196	0.449	0.973	0.022	0.302
26 Expts	295	197	16.212	0.002	-0.165	0.000
27 Diss	296	198	3.613	0.460	0.039	0.173
28 Bio	295	200	6.935	0.139	-0.066	0.058
29 Morex	294	197	6.186	0.185	-0.069	0.047
30 Demos	293	197	3.568	0.467	-0.068	0.047
31 Phyi	294	198	12.787	0.012	0.129	0.001
32 Heur	292	196	13.294	0.009	0.134	0.000
33 Hau	287	195	52.172	0.000	-0.264	0.000
34 Likexp	285	197	5.974	0.201	-0.040	0.161
35 Tea	284	196	5.823	0.212	-0.022	0.304
36 Teadi	287	194	26.537	0.000	-0.189	0.000

(SS=Science Secondary Schools; NS=Nonscience Schools)

Appendix IV

Interview Schedules - Development And Procedures

The development of the interview schedules and the general research questions that directed the data collection were inter-related. The interview schedule questions came from two sources. First was a review of the literature on science education innovations. From the review I was able to identify four themes that characterize innovations in science education, especially in developing countries. These are explored in Chapter 2, and relate to origin of innovations, determination of their need, their characteristics and their outcomes. The review therefore served the vital purpose of sensitizing me to the fundamental issues to be sought for during the field work. Incidently, the review also enabled a clearer formulation of the basic questions which guided the data collection.

The second source of the questions for the interview schedule was a preliminary analysis of documents connected to the establishment of the Science Schools project which I was able to collect prior to the field work. Although some of the more general questions prompted by the literature review and the more broad aspect of the research questions were answered in some of the documents, nevertheless the substantial questions on nature of the project were not answered by the documents.

Based on these two sources, four interview schedules were developed and a series of interviews were held with key informants, Science Board officials school Principals and teachers using an interview schedule with each group of interviewees. Before starting the field work, I had already contacted some of the interviewees. At the field site, some were more available than others; lack of access being attributed to the powerful positions, in commerce and civil service some of the key informants have attained.

My main strategy was to try to contact and interview members of the Kano State Manpower Development Committee of 1975. But tracing even a few of the 17 members of this Committee proved quite difficult. (No one actually knows their full number, but the information brief concerning the Committee gave 17 representatives in 1975). Some have left the Kano State Civil Service quite a while ago, and most cannot be traced. Others represented government establishments at that time that no longer exist.

The difficulty is also partly caused by the time lag between the time the Committee was most active (1975) and when this research started (1985). In the end, I had to be content with attempting to trace the Chairman of the Committee, who was also the Commissioner of Economic Planning in Kano at the time (1975). This was with the view that since he controlled the Committee, he may be in a position to provide a comprehensive set of rationales and strategies governing the genesis of the project, far more effectively than other individual members of the Committee.

Tracing him, however, was not entirely easy because of the complexity of the bureaucratic channels that complicated access to officials. Eventually, however, access obtained to him through contacts, and finally an interview was held. From this interview, clues about other most important members of the Committee emerged, and three of these were also traced andinterviewed. These four became key informants and provided sufficient information on the initiation of the Science Schools Project.

The initial items for each schedule developed was 33 for the key informants, 58 for the Science Board officials, and 81 for the Principals of the schools. The number of items in the teachers' schedule had 95 items.

The main questions for the teachers' interview schedule were clarified after an analysis of the Nigerian science curriculum materials (see Chapter 6). The curriculum materials' analysis revealed the curriculum developers have certain views about the way science should be taught to students. The teachers' interview schedule, as well as the classroom observations (see Appendix 2, and Chapters 6 and 7) were therefore substantially guided by the analysis of the science curriculum materials.

The total number of recorded interviews was with 16 individuals. This was distributed as 3 key informants (Dr Ibrahim Ayagi, Dr Aminu Dorayi and Alhaji Ado Gwaram), 4 administrative officials (Science Board including the Executive Secretary, Alhaji Aminu G Bichi), and 5 Principals (D/Tofa, D/Kudu, Taura, Gwale and Dala). Two principals (Birnin Kudu and Science School K/Hausa) were not possible to interview due to logistic problems.

Although I observed the classroom teaching of 15 teachers (7 Science School and 8 nonscience school), the actual teacher interviews which were recorded was five (3 in Science Schools and 2 in nonscience schools), because were those who do not mind having their views recorded. Informal discussions about teaching science directed by the interview schedule in the various schools were held with the rest of the teachers and the relevant information recorded only in my field work diaries and notes.

Similar techniques were used for interviewing each category of respondents and involved setting up an appointment at a future date, and with the full knowledge the interview will be recorded on tape where this would be allowed. The duration of the interview depended on the respondent. In one interview with a key informant we spent over almost three hours. Another interview with a teacher lasted barely forty minutes. But on average the duration of the interviews was an hour and a half.

There were quite a few cases where recording was not possible; either because the interviewee felt uncomfortable with the machine, or because it was made clear to me the interview will not be taped. On two occasions I was made to stop the tape machine while an informant yielded views which he felt might be misconstrued if made openly a public domain. On one occasion I was allowed to tape what the respondent felt was a particularly sensitive point, but requested not to quote him on that. On yet another occasion I was given an information during an interview which the respondent asked me not to use "for anything serious." But despite these quirks, the interviews were straightforward and quite informative.

Although interview schedules were developed and taken to the field site, it was not in all cases where the schedule was adhered to precisely. Indeed often the interview itself followed an erratic pattern. For instance in the process of answering one question, many were also answered; or issues were raised that necessitated asking a question immediately which was to be asked later. Also questions which were not part of my schedule suddenly emerged from an explanation given to a definite question. And in all cases, I had to prune the item list and concentrated only on asking questions that could not be answered in any way (such as by documents or personal observations).

Interestingly, none of the respondents expressed any ambiguity about any of the questions. However, in one Principal's interview, he insisted on doing a "practice" interview first, which was off record, before the actual interview. This constituted simply of making me explain the information I expected to get with each question. Once he was satisfied he could answer all the questions, he then allowed the interview proper to be recorded, during which, interestingly enough, he provided quite a few contradictory (to documents and observations) pieces of information.

Pruning the interview schedules became necessary, especially with the key informants, who have now become important figures in the civil service (which posed a problem of access) who lacked the patience as well as the time to answer every question listed in the schedule. In these situations, I adopted the strategy of asking some leading questions and allowed the respondent to talk as freely as possible. In one instance, a respondent talked for almost two hours. Indeed he became so engrossed in his narrative that he was rather irritated by my attempts to keep his discourse according to the specified schedule. But in the end I yielded and allowed him to talk - as he clearly wanted to. The end product was over two hours (and 17 pages of manuscript) of discourse that provided the most detailed mechanism of the origin of the Science Schools project. A lot of the information he gave could not have been obtained if we had stuck to the interview schedule.

All the interviews were transcribed at the field work site. This was particularly useful as it enabled me to check over what was recorded with the more available respondents. None of the respondents expresse dissatisfaction with the interview transcripts or suggested an addition or deletion. The material from the interview transcripts was incorporated directly into my write-up, and formed the bulk of Chapters 5 and 7, and contributed to Chapter 6. As such treatment of the interview data was qualitative, and no attempts were made to quantify any of the interview items or responses.

The Science Board officials followed a structured format. The most informative interview was with the Executive Secretary, as well as the Adviser to the Board (who, incidently, was also a one time Executive Secretary of the Board). The interview schedule with the main officials of the Science Board is reproduced here to illustrate its structured nature.

Science Board Officials' Interview Schedule

1. Can you tell me how the science schools in Kano came to be established - their history, years of initiation, those involved at that stage and so on.
2. Are the schools based on a model from another place? If so, which place is this and what modifications were made to the original idea?
3. Could you tell me something about the composition of the Science Board? For instance, what is the criteria used to determine membership and Chairmanship? Who makes these decisions?
4. What is the relationship between the Science Board and the Ministry of Education, Kano? Could you please explain? What was the composition of the Board during the civilian era? (1979-1983). What has been the effects of this control on the science schools?
5. What has been the effects of the frequent changes in the membership of the Board, especially on the schools?
6. Could you tell me how the Board translates the objectives of the science schools into practice? I am particularly interested in how the Board specifically operates: the frequency of its meetings, what range of issues are normally discussed, and the methods of implementations of these issues and results.
7. I understand that Dawakin Kudu and Dawakin Tofa science schools were based on converted nonscience schools. Why were these two schools specifically selected for conversion to science schools? What happened to the original students of these schools?
8. What were the main problems faced during the establishment of the girls science school? The girls science schools was newly built; why was the same principle not applied to the establishment of the boys' schools?
9. Could you explain to me the procedure used for selecting students to the science schools? What are some of the problems you face in this? What is the role of the parents in this? How representative of the Kano

population are the students for the science schools? What is the evidence for this, and to what do you attribute this?

10. The WAEC entrance figures available shows a big difference between the projected and actual population of students in the science schools. What do you think may be responsible for this?
11. What happens to those students who cannot cope with the demands of the science secondary schools?
12. What exactly is the administrative relationship between the science Board and the Ministry of Education? Do you find that an advantage or disadvantage? Why do you say that?
13. What is the administrative structure here? Could you tell me how the Board is organized (do you have any organizational chart?) Does it work like this always? I am also keen to know about any sub-unit you may have.
14. What problems have arisen with the Science Schools in Kano? How has the Board reacted to this, and what were the results?
15. Could you tell me how the Board evaluates the science schools as a whole? Who does evaluation? How frequently is the evaluation done? Can I see any report of a recent evaluation done?
16. In what ways would you say the science taught to the students in the science schools is different from the science of the nonscience schools?
17. What are the teaching styles and techniques recommended by the Board to the teachers of the science schools? What is the rationale of this style of teaching science?
18. How suitable would you consider the National new science curriculum to the achievement of the objectives of the Science Schools? Could you please explain further?
19. What would you say are the effects of the prevailing Islamic culture in Kano on the concept of the science secondary schools?
20. Would you welcome more or less involvement of specialized service sectors, such as industries in the activities of the science schools? What about the civil service in general? What would you say is the demand for your students in the labor market? Can you show me the evidence of this? Why do you think this is so?
21. How does the Board recruit its science teachers? What are the range of problems does the Board face in this process?
22. What qualities does the Board look for before employing a science teacher? In what ways do you feel these qualities are helpful to the science schools?
23. What does the Board sees as the advantages of employing expatriate teachers? In what ways are the views of these expatriate teachers about science and science teaching shared by the Board?
24. How does the Board evaluates the performance of the science teachers in the science schools?
25. What has been the role of the Science Teachers' Association of Nigeria in the affairs of the Board?
26. What is the relationship between the Board and the local institutions of higher learning? Could you give me examples? Would you want to see more or less involvement from these institutions? Why do you feel so?
27. Which science books have been selected or approved by the Science Board for the science schools? What criteria does the Board uses to select science textbooks for the science schools?
28. Could you tell me how laboratory equipment is selected and distributed to the science schools? What are some of the problems do you face with laboratory equipments for the science schools?
29. What have been the achievements of the science schools since they were established? Could you please explain?
30. What do you feel the science schools can offer or achieve which cannot be offered or achieved by the nonscience schools if similar attention is given to them?
31. In what ways does what your former students do now reflects what they learnt in the science schools?
32. Would you want to see more or less investment in the science schools in Kano? In what ways can this be shown?

Appendix V

Documentation On Science Schools

There are two broad classes of documents consulted during this research. The first are documents that are considered classified and not available for public consumption. These documents generally describe the routine mechanism of the Science Schools. They contain internal memos, official notifications, committee decisions and recommendations and minutes of various meetings. It is quite difficult to build a full - and true - picture of the Science Schools without access to these documents. The Board, however, was fully aware of my research and in a letter written to me in August 1986 and signed by Principal Education Officer (Schools), promised full support during the field work. This enabled me to gain access to a wide range of documents. In addition, I was also able to obtain the entire 1984/85 minutes of the Science Board from an informant.

I have incorporated the information yielded by these documents at various points of my data analysis, openly acknowledging their origin. The ones I consulted are listed below by date. I have also summarized the information they contain.

Main Documentary Listings

1. 16th March 1977, from Executive Secretary to Permanent Secretary, Ministry of Education; providing information about the establishment of the Science Schools project, and the Ministry of Education schools to be taken over at Dawakin Kudu and Dawakin Tofa as the new Science Schools.
2. 23rd March 1977, from Executive Secretary to Assistant Secretary - Professional; memo on strategy for conducting entrance examinations for students to Science Schools.
3. 24th March 1977, from Executive Secretary to Secretary, Kano State branch of the Science Teachers Association of Nigeria; letter requesting for a representative on the panel that selects students for the schools.
4. 25th March 1977, Science Secondary Schools Management Board tentative programme of action; gives a month by month account of the activities of the Board from April 1977 to formal opening of the schools in September 1977.
5. 25th March 1977, from Executive Secretary to Assistant Secretary Professional; memo providing information about equipping the Science Schools with equipment "to ensure both teaching techniques and learning styles applied are relevant and result oriented."
6. 29th March 1977, from Permanent Secretary to Principals of two schools to be taken taken over; information about forth-coming inspection team from Science Board.
7. 13th March 1978, from Principal, Dawakin Kudu Science Secondary School to Executive Secretary; memo which proposed "constructive guidelines to help in future curriculum planning within the Science Secondary Schools under the management Board."
8. 8th September 1978, from Adviser, J M Marcroft, to Principals of all the Science Schools; memo on standardization of academic subjects in the Science Schools. Gives a list of subject combinations.
9. 20th December 1978, from Principal Dawakin Tofa Science School, to Executive Secretary; the first detailed strategy on conducting selection examination for the Science Schools.
10. 24th January 1979, from Executive Secretary, to all secondary school Principals in Kano State; information about selection examination. Requests for such information to be brought to attention of students.

11. 25th May 1979, from the Director, Comparative Education Studies and Adaptation Centre, University of Lagos, to Executive Secretary; letter indicating CESAC's interest in the Science Schools. Suggests the latter adopt the Nigerian Secondary Schools Science Project materials.
12. 20th August 1979, follow up letter from the Director, Comparative Education Studies and Adaptation Centre, University of Lagos, to Executive Secretary; about earlier communication. Confirms interest in the Science Schools.
13. 7th January 1981, from Executive Secretary to Principal, Kura (where girls Science Schools was temporarily located before moving to Taura in January 1985); gives approved subject combination for "our students staying in Kura". Recommends 27 periods per week in Science for girls Science School students divided into 5 periods each for Biology, Chemistry and Physics, and 6 each for Mathematics and English Language.
14. 24th June 1981, from G T Menacharil on behalf of science teachers at Dawakin Kudu, to Executive Secretary; "a proposal to set up professional services within the Science Secondary Schools Management Board." Complains that the KERC - advisory unit of Ministry of Education - should not be involved with the Science Schools except for inspection only.
15. 12th December 1981, Dawakin Tofa Science Secondary School Guidance and Counseling Report 1980/81 (DT/Sci Sec/381/II/22). Written by Mr A R Ellis, "Teacher i/c Guidance and Counseling" Provides comprehensive information about the efforts made by the school to guide the students on proper institutions to choose for advanced education.
16. 6th January 1982, from Executive Secretary to Principal, Kura on the procedures for equipping the girls Science Schools section of the school.
17. 27th July 1982, from Acting Vice Principal Dawakin Kudu, to Executive Secretary; report of a committee on the curriculum of the Science Schools. Suggests some other subjects should be taught, besides only science in the Schools. Recommends Health Science and Economics which the Committee "felt is essential for broadening the scope of the Science Schools curriculum."
18. 29 April 1983, Dawakin Tofa Science Secondary School Guidance and Counseling Report 1982 (DT/Sci Sec/381/II/111). Written by Mr A R Ellis,
19. 5th April 1984. Mimeo. History and Organizational structure. Provides details of committees under the Board which run the Board in absence of Members.
20. n.d. 1984. Mimeo. Short Brief on the Science and Technical Schools Board, Kano State. Summarizes the development of Science Schools and discusses their achievements up to 1984.
21. 19th October 1984, from Principal, Taura girls Science School, to Executive Secretary; memo on the need to provide full infrastructural facilities for the newly opened Science School which transferred from Kura with new students.
22. 4th February 1985, from Executive Secretary to Director of Education, Kano State Ministry of Education, letter complaining of lack of cooperation from female nonscience school institutions who refused to allow their selected students to go to Taura girls Science School.
23. 26th February 1985, welcome address to Chairman and Board members from Principal, Science School Taura, on inaugural visit.
24. 8th November 1985, welcome address from Principal, Science School Taura to Military Governor of Kano State, Lt.Col Ahmad Muhammad Daku on a visit. In both two documents, the Principal complains of lack of infrastructural facilities such as adequate water, electricity and insufficient laboratories.

Minutes of the Board's Meetings, 1985 (Highlights Only)

1. 23rd January 1985. Inaugural meeting of a newly constituted Board (last Board was appointed in dissolved in 1979); reports of the reorganization of the Board and inclusion of Technical and Vocational Schools under the Board. Board's name now changed to Science and Technical Schools Board. Discusses problems

facing the schools, mainly "mass resignation of indigenous members of staff due to lack of facilities." Scheduled six meetings for 1985.

2. 23 January 1985. Board Meeting. Recommends establishment of sub-committees including Academic Committee
3. 17th April 1985. Board Meeting. Discusses maintainance vote, and report from Academic Committee (Board Paper 26/4). Provides information about the programme of examinations and interviews for student selection. Outlines admission procedures into the Science and Technical Schools.
4. 17th April 1985. Report of familiarization visits to schools under the Board (Board Paper 26/3) Heard complaints from all schools about insufficiency of facilities
5. 24th July 1985. Report from Academic Committee suggests the number of students to be sent to each of seven schools under the Board. Reports also on the conduct on the recently concluded entrance examination exercise, and criteria for passing and placement.
6. 24th July 1985. Board notes report of Academic Committee and "forwards the lists of selected candidates to Ministry of Education for approval."
7. 20th November 1985. Report from Academic Committee, Board Paper 28/4. Reports "it is very alarming that about 390 candidates who were offered admission into schools under the Board have not yet reported." Analyses GCE 1985 results and "was not satisfied with the performance of the Taura students (at Kura)."
8. 20th November 1985. Matters Arising from Academic Committee (Board Paper 27/4) discussed. The main issue of Aptitude Testing for the selected students for the Science Schools was also discussed. Suggests setting up own Aptitude Testing facility within Board. Board also discusses 1985 GCE ordinary level examination results, and directed that "Principals should be asked to explain why, in subjects the students performed below average (50%)."
9. 20th November 1985. Report on recruitment exercise conducted by Senior Staff Establishment sub-committee. Reports on the recruitment of teachers in all subject areas, and the problems faced.
10. 20th December 1985. Board notes many students offered admission to Science Schools did not turn up, despite many letters sent to their former schools. Board also expresses fears that "the Ministry of Education might not complete the capital projects by the end of the 1985 fiscal year."
11. n.d. February 1987. Mimeo. Current statistical information on the student and teacher population in all schools under the Board.
12. 30th July 1987. Document. Dawakin Tofa Science School 3rd Speech and prize giving programme. Gives full details of the achievements of the school since establishment.

Other Documentary Sources

1. On 27th February 1986, the Kano State owned Television station (CTV) broadcast a programme on the Science Schools called The Dawaki Experiment (Presented by Aminu Mahmoud). I was able to obtain all the documents associated with the production of the programme. This included film footage as well as master tapes of interviews conducted with key informants for the programme. The documents I used in this thesis are listed here, and acknowledged in the thesis as **CTV Documents**. It is interesting to note the differences in tone and emphasis between these documents and those listed above. It should be remembered the CTV documents are meant for a public programme which highlights the achievements of the Science Schools.
2. 16th November 1985. Mimeo. Speech delivered by President, Kano Science Secondary Schools Old Students Association (KASSOSA), at First Science Week opening ceremony at Dawakin Kudu Science School. Outlines the aims of the Association and its hopes for Kano State future science education.

3. 23rd November 1985. Mimeo. Address by Principal, Dawakin Tofa Science School, Alhaji Kabiru Sani Hanga, to PTA General Meeting. Highlights achievements of the school.
4. n.d November 1985. Mimeo. A brief delivered by the Executive Secretary, Science Board at inaugural visit to the Science and Technical Schools Secretariat by Military Governor of Kano, Lt.Col. Ahmad Muhammad Daku. Outlines the achievements of the Board.
5. 6th January 1986. Mimeo. Science Secondary School Dawakin Kudu: prospects achievement and constraints. Brief produced by Dawakin Kudu Science School for the CTV Programme. Identifies teachers as the major constraints, as well as lack of funding.
6. 6th January 1986. Mimeo. Programme transcript of The Dawaki Experiment. Incorporates all interviews with key informants for the Programme.

Examination Outcomes of the Science Schools

Detailed information concerning the achievement of the Science Schools in the General Certificate of Education ordinary level examinations is considered classified, although this was less difficult to acquire than other documents. Indeed the Science Board was only too happy to supply detailed examination results of the students from the Science Schools. And because these results are quite vital to an appreciation of the outcomes of the project, they were summarized in Chapter 8. The full details, however, are reproduced here. To make the listings less tedious, I have rearranged the figures according to year and combined all the schools in one table.

My emphasis in considering these examination results is not on the internal consistency of the examination procedure or its validity. I use the results, as supplied by the Science Board, only to emphasize the criteria used to judge the outcomes of the project by the Kano State government. Any sampling of subjects and subsequent justification is based on this rationale only.

Only the results of the five main subjects are reproduced here. These are Biology, Chemistry, Physics and Mathematics. English Language is included because it is compulsory to all pupils (as was also Mathematics) in Nigeria. These subjects are chosen because they form the core of any further education in scientific or technological disciplines in Nigeria. A student must pass them at credit level before studying any scientific or technological discipline in Nigerian higher institution. What I have reproduced here are both the credit results of all the students in the Science Schools from the first time the schools offered students for the GCE examination (1980) to 1987. The figures computed here are based on examination results documents made available to me by both the Science Schools Board, and in some cases, the individual Science Schools themselves. All rearrangment was my own and done in consistence with the theme of this thesis.

Table V.1: Dawakin Tofa Science School Credit Level GCE Ordinary Level Examination Results, 1980-1986

	Biology		Chemistry		Physics		Maths		English	
Year	No	Cre	No	Cre	No	Cre	No	Cre	No	Cre
1980	85	15	85	37	85	28	85	33	85	10
1981	67	9	67	26	67	12	67	20	67	1
1982	157	24	157	53	57	29	157	57	157	4
1983	112	38	12	21	112	35	112	36	112	14
1984	168	54	168	70	66	20	167	37	166	33
1985	236	19	236	99	236	55	237	87	236	1
1986	28	113	228	161	228	44	228	43	228	25

Total	**1053**	**272**	**1053**	**467**	**1053**	**223**	**1054**	**313**	**1053**	**88**

Table V.2: Dawakin Kudu Science School Credit Level GCE Ordinary Level Examination Results, 1980-1986

	Biology		Chemistry		Physics		Maths		English	
Year	No	Cre	No	Cre	No	Cre	No	Cre	No	Cre
1980	97	45	97	41	97	44	97	46	97	19
1981	158	30	157	67	157	49	185	52	158	45
1982	145	37	146	34	151	52	150	45	143	13
1983	183	46	181	68	183	100	183	92	184	38
1984	205	99	204	72	199	44	204	59	205	24
1985	213	128	213	94	213	114	213	116	213	20
1986	237	138	237	152	237	119	237	101	237	6
Total	1238	523	1235	528	1237	522	1269	511	1237	165

Table V.3: Taura Science School Credit Level GCE Ordinary Level Examination Results, 1984-1985

	Biology		Chemistry		Physics		Maths		English	
Year	No	Crd	No	Crd	No	Crd	No	Crd	No	Crd
1984	64	19	64	14	65	7	64	5	64	12
1985	65	16	63	14	64	8	65	3	64	0
Total	129	37	127	28	129	15	129	23	128	12

These results expressed the number of students who got *credit level* scores in these subjects. It is not possible to determine how many of the students got credits in all the five subjects listed here. All the results show are the number of students who got credits per each subject.

However, the emphasis of the Science Board when using the examination results as a pointer to the successful outcome of the project lies more on projecting the overall pass level results. These results include many scores (non-credit) that will not be a basis for registration for studying the subject in higher institutions. The overall GCE examination pass results, which includes the credit scores from the Science Schools from 1980 to 1987 are reproduced below.

Table V.4: Dawakin Tofa Science School GCE Ordinary Level Examination Passes, 1980-1986

	Biology		Chemistry		Physics		Maths		English	
	No	Pass	No	Pass	No	Pass	No	Pass	No	Pass
1980	85	49	85	46	85	39	85	65	85	35
1981	67	19	67	50	67	27	67	44	67	25
1982	157	44	157	98	157	72	154	126	157	25
1983	112	60	112	52	111	67	104	65	112	98
1984	168	114	168	99	166	61	167	83	166	98
1985	236	38	214	138	215	102	216	136	216	29
1986	228	180	228	207	228	105	228	91	228	58
Total	1053	504	1053	690	1051	473	1053	610	1051	368

Table V.5: Dawakin Kudu Science School GCE Ordinary Level Examination Passes, 1980-1986

	Biology		Chemistry		Physics		Maths		English	
Year	No	Pass	No	Pass	No	Pass	No	Pass	No	Pass
1980	97	72	97	71	97	61	97	72	97	58
1981	158	54	157	119	157	94	185	67	185	60
1982	145	75	146	70	151	111	150	106	143	23
1983	183	85	181	126	183	163	183	156	184	95
1984	205	170	204	111	199	108	204	127	205	96
1985	213	198	213	144	213	178	213	186	213	62
1986	237	204	237	208	237	209	237	178	237	38
Total	1238	858	1235	849	1237	924	1269	892	1237	432

Table V.6: Taura Science School GCE Ordinary Level Examination Passes, 1980-1985

	Biology		Chemistry		Physics		Maths		English	
Year	No	Pass	No	Pass	No	Pass	No	Pass	No	Pass
1984	64	44	64	26	65	25	64	13	64	27
1985	65	56	63	37	64	25	65	21	64	8
Total	129	100	127	63	129	50	129	34	129	35

In considering these results, it must be kept in mind they include the credit level scores. The overall credit level and pass results are summarized below. Tables V.II and V.III exclude Taura 1986 results which were not available.

Table V.7: Science Schools GCE Ordinary Level Examination Credits, 1980-1986

Subject	Number	Credit	Pct
Chemistry	2415	1023	42.3
Maths	2452	832	34.0
Biology	2420	830	34.2
Physics	2419	760	31.4
English	2418	265	10.0
Average	**2423**	**742**	**30.6**

Table V.8: Science Schools GCE Ordinary Level Examination Passes, 1980-1986

Subject	Number	Passes	%
Chemistry	2415	1602	66.3
Maths	2452	1536	62.6
Biology	2420	1462	60.4
Physics	2419	1447	59.8
English	2418	835	34.5

Average	2424	1374	56.6

Other Achievements of the Science Schools

Besides final examinations, other achievements of the Science Schools are recorded here to provide an insight into their full nature. These achievements constitute the success of the students in science fairs and competitions in Nigeria. However, achievements for the older Science Schools are more comprehensively documented than for the newer Science Schools. And even then, there is a great difference in the way the achievements are chronicled by the individual schools. The Dawakin Tofa Science School by far seemed to be the most organized in listing all the achievements of the school, as such I am reproducing the achievements of the school here. It has not been possible to obtain similar chronicle from the Dawakin Kudu Science School. Indeed as the Dawakin Kudu authorities explained,

> "The measurement of achievement has always been a difficult task which if care is not taken, may sound meaningless. This is because some achievements are only perceptible rather than quantifiable. However, Dawakin Kudu Science Secondary School has particularly excelled itself in science exhibitions, and quiz contests, winning both at the state and National levels on several occasions." (CTV Documents 6/1/1986)

Nevertheless, the Dawakin Tofa Science School was able to list its own achievements besides examinations. These are reproduced as given in the 10th Anniversary booklet of Speech and Prize giving ceremony of the School held on Thursday 30th July 1987.

1. January 1979: Islamic Studies Society of Kano Quiz Contest; 1st position November 1983: Young Scientists Quiz Competition (National Level held in Lagos); 1st position
2. April 1984: Mathematical Association of Nigeria (MAN) National Quiz Competition; 2nd Position
3. November 1984: National Young Scientists Quiz Contest, Kano State level: 1st position
4. January 1985: Islamic Studies Society of Kano Quiz Contest; 1st position February 1985: Ahmadu Bello University Macroscope Science Quiz Exhibition contests for Secondary Schools in Nigeria; 3rd Position
5. May 1985: Chemical Society of Nigeria, Quiz Contest Kano State level; 1st position
6. September 1985: City Television (CTV) Schools Challenge; 1st position
7. October 1985: Maths Quiz Contest, Federal Government College, Kano; 2nd position
8. November 1985: Nigerian Television Authority Kano Quiz Competition; 4th position
9. January 1986: Quiz Competition/Speech Contest of the Ahmadiyya Secondary School's 10th Annual Islamic Functions; 1st position. Won Trophy
10. March 1986: Ahmadu Bello University Macroscope Science Quiz Contest; 1st position
11. May 1986: Bayero University Kano Physics Festival Quiz Competition; 3rd position
12. May 1986: Science Teachers' Association of Nigeria (STAN) Quiz Contest Bichi/Dawakin Tofa Zone: 1st position
13. June 1986: Kano Educational Resource Centre "Science is Doing" Quiz Contest; 4th position
14. June 1986: Young Brains - Nigerian Television Authority Kano Science Quiz Competition; 2nd position
15. June 1986: STAN Quiz Contest Bichi/Dawakin Tofa zone; 1st position November 1986: National Young Scientists Quiz Competition Finals for Kano State; 1st position
16. December 1986: National Young Scientists Quiz Competition Finals National level held in Kaduna; 2nd position
17. February 1987: Muslim Corpers Association of Nigeria Islamic Quiz Competition; 1st position
18. March 1987: Nigerian Television Authority, Kano "Science is Doing" Contest; 4th position

19. March 1987: Rumfa Old Boys Association (RUMFOBA) Mathematics Quiz Competition; 1st position

But by far the most significant single achievement of the Dawakin Tofa Science School was the examination success of Sarki Abba Abdulkadir a former student who, in 1984 obtained the best results in WAEC GCE ordinary level examinations in Nigeria. For this, the school was awarded the Oba of Benin Trophy by WAEC as a prize while the student was awarded a National Merit Award and cash prize at the 23rd Annual conference of of WAEC on 20th November 1984 at Abeokuta, Ogun State. In appreciation of his efforts, the school named its library building after him. Incidently, in the above list of the Schools achievements, he was the sole participant from the school during the April 1984 Mathematical Association of Nigeria Quiz Competition, at which reached the 2nd position. (See Sunday Triumph 29th December 1985 p.5)

The achievements of the Dawakin Kudu Science School, as mentioned earlier, were not detailed in any document. However, a CTV Document (see above) provided the list of students from the Dawakin Kudu Science School who gained university admission. This is given in Table V.9.

Table V.9: Dawakin Kudu Science School University Level Output, 1980-1985

	Number		
Year	**Grad**	**Qual for Univ.**	**%**
1980	98	37	37.7
1981	168	32	19.0
1982	166	37	22.2
1983	188	82	43.6
1984	205	65	31.7
1985	213	95	44.6
Total	**1038**	**348**	**33.5**

Open Access Documents

The second class of documents contains all information that is public domain. These are listed in the references section, although two of the more relevant ones to the understanding of the origin and mechanism of the Science Schools project are reproduced here.

The first is the education section of the 1976/77 Kano State government policy statement that outlined, although briefly, the government's intention to start the Science Schools project. Its brief nature masks the intense behind the scenes struggles that went into the genesis of the project as accounted in Chapter 5. The policy statement is reproduced below.

The second open access document is the Science Schools Law published in 1982. The Law was issued by a civilian administration, but its prototype was a Science Secondary Schools Management Board Decree issued by the then Military Governor in 1977. Since the Decree and the Law were basically the same, with the only changes in personnel titles and inclusion of the Technical Schools under the Science Board, I have chosen to reproduce only the Law.

A third source was a mimeo produced by the Science Board (listed above as being written on 5th April 1984). This summarizes the history of the Science Schools project, and provides details of organizational structure. I am reproducing it here to serve as an alternative listing in case of lack of access to the other documents listed above. Another source is Kano State 1979b (listed in references) which provides a section on the Science Schools project, including budgetary allocations for the first three years of the project.

INFORMATION SHEET TO STUDENTS

SOME QUESTIONS FOR BOYS AND GIRLS WITH SCIENTIFIC TALENTS

Are you a boy or girl from Kano State	Yes/No
Are you now in Form 2 at a Secondary School in Kano?	Yes/No
Are you intelligent and have you a special interest in the Sciences?	Yes/No
Do you hope to have a career in the Sciences (For example engineering,,	
Medicine, architecture, biochemistry, minerology, agricultural, research,	
Dentistry, maths meteorology?	Yes/No
Would you like to attend a school with special features for Science	
(good laboratories, excellent equipment, first rate teachers)	Yes/No

If you have answered YES to all these questions, read on.......

Selection examinations will soon be held in your school for boys and girls hoping to join one of the Kano State Science Secondary Schools in September,
1979.

In these Science Secondary Schools students take English Language, Mathematics, Biology, Chemistry, Physics, Geography, Technical Drawing, Additional Mathematics, I.R.K. and Hausa.

In addition there are the usual sports facilities and many clubs and societies.

If You Intend To Be A Top Scientist In A Few Years Time, Your Place Is At A Science Secondary School.