Science Forum 2000

Provisions for **Education** *in* **Science** in Kano in the Next Millennium

Consultant's Report

Prepared by

Abdalla Uba Adamu
Department of Education
Bayero University, Kano

Kano: October 1999

Table of Contents

List of Tables

Science Forum 2000

General Introduction

The report, commisioned by The Kano Abuja Forum[1] is divided into two broad sections: an Executive Summary and a Main Report divided into two parts. The *Executive Summary* however, deviates from its standard format by providing key *decision-making points* concerning what the Forum can do to bring about change. Further, it is written from an *educational*, not economic perspective. Consequently it focuses attention on *why* the schools declined and the remediative measures that need to be taken to correct the problem. Most of the problems, actually started manifesting themselves early enough, but they were ignored — leading to the present sad situation.

Masses of data about the economic aspects of the schools in terms of actual cash requirements needed to physically rejuvenate the schools are detailed in the appendices attached to the report. Similar data about teacher welfare, which I is not covered in this pilot report, is adequately provided in the appendices attached.

The *main report* provides the empirical data on the state of the schools since inception. Part One deals with historical development of the Colleges, paying particular attention to areas that made success possible in the first place. Part Two deals with the present and provides a synthesis of FGD results as well as excerpts from reports about the status of the schools. The report is supported by a series of Appendices.

The Science Schools concept is a universal idea. It has been extensively developed in the United States, where I was opportuned to be in direct contact with one of them. I have photocopied and attached in its entirely, the student handbook from this particular school which I think provides a brilliant strategy for the welfare of specialized science students. It is listed as ***Appendix 1***. Looking at the handbook closely, one can see that it is actually a reflection of what obtains in the Kano State Science schools in their halcyon days. Further, in the United States exist a network organization that links all the science colleges and high schools and thus provide useful insight into the managerial strategies of ensuring a free exchange and flow of ideas between the schools. I have also enclosed a photocopy of the preliminary pages of the network's program (***Appendix 2***). These two documents could help in fine-tuning advocacy strategies of the Forum.

Attached to the report are other appendices. ***Appendix 3*** deals with the bill of quantities of the requirements of the Science and Technical Colleges, which was part of the request sent to the Executive Governor, His Excellency Dr. Rabi'u Musa Kwankwaso, by the new Executive Secretary in October 1999. While it clearly articulates the needs of the schools in terms of building materials, the report is hugely silent on the strategies needed to improve the teaching and learning in the schools. The assumption is that by merely giving

[1] The Abuja Forum is made up of residents of Abuja, Nigeria, who were of Kano State origin. This study was commissioned by a sub-committee of the Forum in 1999. It was subsequently presented to the forum and an implementation committee was thereafter set up to look into the recommendations of this report.

the almost _10.7 million needed, the problems of quality instruction and poor examination results will go away.

Appendix 5 is a copy of the report of the committee set up by the Kano State Government in April 1998 to investigate the reasons for the decline in the examination performance of the Science Colleges from 1980 to 1997. I have decided to include the entire report as it provides an idea of the extent of the problem. A major weakness of the report is lack of student perspectives. Nowhere did the members of the committee deemed it necessary to interact with the students and determine their feelings about the teaching and learning process in the schools. The mistakes made in the establishment of the schools (and there were many) seemed likely to be repeated here: pre-occupation with physical facilities, and little attention on the actual curriculum or its meaning to both teachers and students.

When it was clear that nothing would be done about the report in Appendix 4, yet another committee was set up in April 1999 to evaluate the report! The findings of this committee — full of accusations for the first committee — are reproduced as ***Appendix 4***. Again nothing seems to have been done about this, until the change of leadership in the Board when Alhaji Sa'adu S. Sule was appointed the Executive Secretary on September 13, 1999, to replace Alhaji Tajudeen Gambo (1993-1999), under whose tenure most of the decline in the quality of the schools occurred.

It is hoped this report will provide an avenue for effectively tackling the future direction for science education in Kano. It is this optimism that informed the futuristic title of the report, Science Forum 2000.

Abdalla Uba Adamu
Consultant
Kano, October 1999

Science Forum 2000

Executive Summary

The role of science in the social transformation of any society is no longer in doubt. What is doubtful is the series of strategies needed to achieve social transformation through science and technology. Development theorists almost always ignore the basic fact that science and technology, as current solutions to development, are inevitably refined process of other cultures and other peoples. Consequently their utilization comes with an entrance fee most cultures are not ready, or willing, to pay. The end product is a shot-gun approach to the application of science and technology in solving social problems, and these inevitably focus on the philosophy of "the more the better". Consequently, provisions are seen in terms of more teachers, more equipment and more students.

In Kano State the process of social transformation was embarked on in 1977 with the establishment of specialized Science Secondary Schools, renamed Science Colleges in January 1998. From about 1980 to 1987 they produced spectacular results. Then they stopped producing such results. This report is an attempt to explain why.

The solutions — or at least attempted solutions — to the problems of rejuvenating the quality of the Science Colleges in Kano lie in two broad areas. The main one is ***advocacy***. This requires getting the legislature changed and thus deals with negotiating legislative mechanism around which change, perceived to be for the better, or at least better than what is currently available, can be effected. This may mean sponsoring a bill to be adopted in the House of Assembly, or at least convincing the Chief Executive of the desirability for change to improve the current situation. The summary of the points requiring advocacy may include

1. Negotiating change from within: getting a seat on the Board
2. Total severance of links with Ministry of Education
3. Decentralization of the present Board
4. Creation of a Board for Science Colleges
5. Creation of a Board for Technical Education
6. Reduction of the number of Science Colleges to three: two for boys and one for girls, and all to be fully boarding
7. Direct control of the Boards under the Governor's Office
8. Reconstituted Board structure to de-emphasize political leanings, and pay more attention to science education development of the schools
9. Introduction of Junior Secondary Schools *within* the Science Colleges which will provide a more firmer foundation for the Senior Science College entrants
10. Introduction of specialized Science Primary Schools
11. Introduction of Remedial Classes in Year I of the Colleges
12. Linkages with other Science Colleges/industries

The second set of solutions revolve around ***direct action activities*** which the Forum could undertake on the behalf of the schools. The most immediate of these, of course, deal with supportive financial provisions. This strategy, however, is not without its problems. For instance, if the Forum is to give money, *who* should it be given to among possible monitors: the Colleges, the Board, the Ministry or Government House directly? Further, *how* can the Forum *ensure* that the money gets to where it is supposed to? How can the Forum ensure that its contributions have made the *impact* envisaged? Among some of the possible support areas the Forum can engage in directly, the following might be included:

1. Establishment of an Independent Monitoring and Evaluation Agency
2. Provision of Library materials: books and journals.
3. Enhancing the science curriculum of the schools through introduction of extra hours and extra methodologies
4. Provision of sports facilities
5. Provision of other facilities dealing with leisure and recreation — television, video, possible cable television
6. Provision of computers and computer instructors *from outside the colleges*.

Advocacy Strategies

1. *Negotiating change from within: getting a seat on the Board*

Perhaps one of the most influential way of bringing about change is by ensuring the continued presence of at least two members of the Forum on the management Board of the schools, no matter its political configuration. Through membership, the Forum can only ensure change is along its general directions at the Board level; plus it provides a means of monitoring the general direction of the schools.

2. *Total severance of links of the Science Board with Ministry of Education*

It is clear that a lot of the inefficiencies of the Science Board were attributable to its umbilical linkage with the Ministry of Education Kano which right from the start, did not believe in the project. There were actually moves, early enough in the project's lifespan, to terminate it. Further, the reliance on the Ministry for Budgeting and control seriously hampers the autonomy of the Board and reduces its impact. Severance, however, should not be acrimonious since both the Board and the Ministry serve the purpose of furthering the cause of Education in the State.

3. *Decentralization of the present Board*

At the moment the Board has too many functions added on to it as it evolved. These included the Technical Schools, Vocational Schools and Centers. These are diversionary as they prevent the Board from providing quality service in one area. It should therefore be decentralized. The purpose of centralizing the functions of the Board in 1982 has clearly been defeated. At the secondary level, there is absolutely no pedagogic reasons to lump provisions for science with the needs for technical subjects in the same place. It is an ill-advised move in 1982. It is still in-advised.

4. *Creation of a Board for Science Colleges*

This should therefore lead to the establishment of an independent Board for Science Colleges, with three colleges under its control and all the attendant bureaucratic machinery of government. The Board will therefore have an Executive Secretary, Deputy Directors and others.

5. *Creation of a Board for Technical Education*
This should provide the Government with full focus on developing lower level technical manpower needed for the State.

6. *Reduction of the number of Science Colleges to three: two for boys and one for girls, and all to be fully boarding*
This means that the Science Colleges created for political reasons — e.g. the Maitama Sule Science College at Gaya — should be fully transferred to the Ministry of Education. Similarly, the Kano Day Science College, an absurdity to begin with, since you cannot realistically have a ***day*** science college, should be converted to a conventional school and handed over to the Ministry of Education. The Colleges at Dawakin Kudu and Dawakin Tofa for boys, and the one at Garko for girls should be more than adequate. After all, only the first two were able to provide the massive (as it were!) professional and technological manpower needed for the State in the mid-1980s.

7. *Direct control of the Boards under the Governor's Office*
Alternatively the new structure could be created as Special Educational Services Unit of the Governor's Office. Then two departments — Board for Science Colleges, and Board for Technical Education — could be created under it and co-ordinated by a single Executive Secretary. This is something for both the politicians and the bureaucrats to work out; but the central idea is that the colleges (both science and technical) would now be under closer supervision and control by the Governor's Office.

8. *Reconstituted Board structure to de-emphasize political leanings, and pay more attention to science education development of the schools*
The Board structure had hitherto pampered to the power-game of Kano. Most of those who served on the Board had not been able to provide the schools with any academic leadership (none of the "scientists" for instance, has ever taught in the schools to demonstrate a scientific principle). Admitted that there role is political; but there was the belief that the science schools are more important than political configurations. The subsequent Board structure must therefore take into consideration the expertise of the members in matters affecting the *academic activities* of the schools/colleges.

9. *Introduction of Junior Secondary Schools within the Science Colleges which will provide a more firmer foundation for the Senior Science College entrants*
A lot of the problems of the schools center around the caliber of students admitted into the schools. It is now increasingly clear that there is not much that can be done about this, unless drastic measures are to be taken. It is often too easily forgotten that the entrants into the science colleges in the late 1980s and who have been producing the dismal results we are all worried about, *were the products of the 1976 UPE mass-education drive which emphasized quantity, not quality*. These products matured into the junior secondary schools in 1982, and by 1985 were already in Senior Secondary Schools. About three years later, in 1988, they became the first benchmark around which the dismal performance of students started to be noticed in examination results.

What further made the situation worse was the introduction of a policy by the Board that admission is based on a quota basis which means that all the 44 local government must be represented. This is more so as the local governments pay _2,000 boarding fees for their sponsored students. This blind desire to generate revenue by the Board means lowering the cut-off point of the entrance examination to as low as 30% — which of course compromises the quality of the students that eventually get admitted.

I would suggest that the best way out is for the Science Colleges to open *Junior Science Colleges* within their premises and thus train their own students. It is easier to spend three years (junior high school) preparing a student for senior high school and expect a better result, than to expect someone from the dismal junior highs to come directly into the Science College and expect to perform. Entries into the Senior Science Colleges could still be open to absolutely the best students from other schooling systems, but priority will always be given to junior science college students, who also must take the senior Science College entrance examination. If they do not pass, they are transferred to a conventional Ministry of Education Senior Secondary School, where they would most likely perform better.

10. *Introduction of Remedial Classes in Year I of the Colleges*
An alternative — and possibly cheaper — advocacy could be the introduction of a *remedial year* in the Colleges so that all students spend one year repeating their JS III and at the same time being prepared for rigorous scientific instruction at SS I. This in effect means that the students will now spend four years instead of three. However transition to the SS I is not automatic. At the end of the remedial year, students will still take the selection examination. Any student who fails is then transferred to a conventional secondary school.

11. *Introduction of specialized Science Primary Schools*
This will serve as a the source for pupils for the Science Junior Secondary Schools. These need not be in the same premises, but could be specially located. Already there are about two of these well-intentioned primary schools in Kano. A partnership could be entered in the process of their funding by both the Board for Science Colleges and the Ministry of Education to ensure that quality is maintained so that they can be eligible to being admitted in the junior Science college.

12. *Linkages with other Science Colleges/industries*
There is a need for a continuous linkages to be kept with other science schools. It is ironic that while the Kano State Science Colleges provides the models for other to follow, the committee set up by Kano State to investigate the performance of the schools found it necessary to go to other States like Katsina and Yobe to see how they organize their science schools!! It clearly shows the extent of the decay of the Kano State schools. At the same time, there is a need to provide an industrial linkage, through an industrial officer, who will ensure that more applicative aspects of science can be concretized for the students through organized field trips. The Board must provide buses or alternative arrangements for this.

Support-Activities

1. ***Establishment*** *of an Independent Monitoring and Evaluation Agency*

This will require the Forum to recruit the services of an independent organization or Agency that will monitor the quality of instruction in the Colleges and *report directly* to the Forum. The strategy suggested is similar to the *modus operandi* adopted by some of the international donor agencies. For instance, USAID, of which I am heavily involved, does not provide any direct financial assistance to Governments or Government Agencies. What they do is allow NGOs to identify community projects for them, and then submit to them for sponsorship. It is the NGOs that executive the programs, with USAID providing not only support, but also monitoring supervision. Any NGO that is found wanting is not patronized subsequently. In this way, US donors to Nigerian development are fairly sure that their donations do get to the intended beneficiaries. Government, of course, welcomes this for many reasons. First it removes from it the onus of proving that it has done a good job; someone else will take that responsibility. Secondly, services are provided to the Government in ways it could not possibly afford to do so itself.

There are at least two ways this can be done. First, the Forum could hire a team of educational consultants to monitor aid to the colleges. Second, the Forum could also initiate a liaison between the Colleges and the relevant Faculties in Bayero University Kano. For instance, the Faculty of Science and the Faculty of Education could be given the task of affiliating the Colleges under a special relations arrangement where the Faculties provide inspectorate, standardization and monitoring of all the programs and teachers of the Colleges. Reports will be sent directly to the Forum, as well as a copy given to the Board. This will, of course, be in addition to the monitoring and evaluation already in-place in the bureaucratic machinery of the Colleges. Such agencies will include impact-measurement mechanism in its activities so that it will also be easily audited by a sub-unit of the Forum (which, for instance, can be called Science Forum 2000, to distinguish it from any other activity of the Forum).

2. ***Provision*** *of Library materials: books and journals*.

From the FGD held with the students of Dawakin Kudu Science College, as well as an inspection of the Library, it is quite clear that there is a need for more books not only in all academic subjects, but also in areas that support the growth and development of science. Currently all the materials are hopelessly outdated and clearly part of the original set of materials given to the schools. It is quite instructive that in the list of materials needed for the rehabilitation of the schools sent to the Governor by the Board (and appended to this report), there was no mention of learning materials! This is one area that the Forum can help. Books must not be seen in terms of dry textbooks; there are many primers that exist to support and interpret science for learners. The Forum can purchase these books for the Colleges.

3. ***Enhancing*** *the science curriculum of the schools through* ***monitoring*** *workshops*

There is a need for the teachers and the students of the Colleges to interact more informally with scientific concepts and principles in a more realistic way that shows science as an everyday activity and an inculcation of a sense of rational values, rather than a subject to be passed at the examinations. This can be done through *quarterly* workshops to be organized by an independent (the

same as before) agency on the behalf of the Forum, and the results sent to the Forum. The Forum will not release funds for any proposed workshop until a full and comprehensive study is made about the feasibility of the workshop, and an evaluation mechanism inbuilt into the workshop.

4. ***Provision*** *of sports facilities*

The FGD conducted at Dawakin Kudu college also reveals that only a football pitch is available as sporting facility in the college. The students bitterly complained of lack of other sports, such as table and lawn tennis, volley and basket ball, etc. They are clearly eager for playing fields in other sports endeavors. The Forum can *supervise* the construction of such needed sporting facilities by recognized experts who will be financially accountable only to the Forum.

5. ***Provision*** *of other facilities dealing with leisure and recreation — television, video, possible cable television*

There are no such facilities for the students in at least Dawakin Kudu, and the students clearly yearn for such. The possibilities of showing educational programs to the students cannot be discounted in providing support to the learning of various concepts. It is therefore vital that at least two sets of television and video be provided for clusters of students so that the teachers can use them as effective teaching aids. In addition, cable programs as broadcast on CNN can help enormously in providing additional incidental educational information to the students, in addition to making them aware of the whole wide world.

6. *Provision of computers and computer instructors* ***from outside the colleges***.

The Dawakin Kudu Science College, at least, has some three or so computers. But according to the students in my FGD group, "…they are only there for decorations…" The claim even the teachers are not longer using the machines. It could be possible, of course, that they have broken down, and no one can be bothered to repair them. As a first step, the Forum can order a full system analysis on the machines to determine their state of usability. They can then arrange to provide more, especially those with multimedia. Currently there are many computer programs that facilitate the learning of various concepts — from Arabic to Nuclear Physics; but available only on CD-ROMs which the computers in the schools currently lack.

A next step in this direction could be the employment of an independent computer college instructor to arrange the computer education of the students in the Science Colleges. That way, both the students and the teachers benefit, with no extra burden placed on the teachers. At least one college in Kano, Ansar Girls' College uses this strategy.

7. *Feeding facilities must be improved*

This is a more or less universal problem for all boarding schools. However, feeding need not be prison-slanderers — which it clearly is, from the FGD at Dawakin Kudu. The students complained of the horrid quality of the food, its monotonous, non-balanced nature, smallish quantity and delays in providing it. For instance, they do not take breakfast — "…just bread and tea, and once in a while, *koko*!…" — until 10.30 a.m. For a 12 year old child, awake since 5.30 a.m. and attending lessons since 8.00 a.m. attention becomes a luxury he

cannot afford when he is hungry. Indeed their desire to escape from the prison-like food and regime of the college is clearly manifested in their repeated requests for the inclusion of EXIT facility which will enable them to visit their homes at least once every two weeks. Thus while they are not clearly starving, they are not feeding well either. Attention spans waver and desire to eat and satisfy an internal hunger takes precedence.

Clearly this is a gray area. The Forum can *advocate* for a better feeding it the schools — to include a lot of green vegetables and other requirements of a 12-18 year old. This can be more effective if, as suggested earlier, the Forum can work it out so that at least two of its members are *members of the Board*. More directly, the Board can provide food items to the schools on a quarterly basis to ensure a balance meal is given to the students. Monitoring this, however, is more difficult than straightforward academic matters, but it is a matter of working out the logistics, if acceptable.

Caveat emptor!

All these strategies make one fundamental assumption: that change is desirable, *possible* and *measurable*. However, interventionist strategies are not magic solutions. They rely on people to accept, support and in the final analysis, implement them. It took a long time (between 1977 to at least 1982) for the spectacular results of the mid-1980s to be noticed in the science schools. A lot of damage has been done to the schools. The current efforts of the Forum should be seen as taking the steps towards damage-containment so that the government can have a better basis for implementing its policies.

Professor Abdalla Uba Adamu
Professor of Science Education and Curriculum Studies
Head, Department of Education
Bayero University Kano
Kano, Tuesday October 26, 1999

Science Forum 2000

Part One

Statement of the Problem

The Kano State Government set up a series of Science Secondary Schools in October 1977 to provide facilities where more Kano State indigenes will be produced in the area of technological and medical disciplines. The project started with two schools, both for boys, at Dawakin Kudu and Dawakin Tofa. By the second phase of the project, from 1980-1986, and with the addition of two more schools the schools have produced about 2,423 pure science students with almost 742 five-credit level passes (30%). However, of the same cohort, at least 1,376 (56%) students passed the examinations. This cohort were able to substantially graduate from universities in various disciplines. Thus by 1993 the total number of scientific personnel produced by the schools was 1,053 which included 92 medical doctors, 221 engineers and 490 scientists, amongst others.

By the third stage of the project, 1988-1997, however, the appears a considerable decline in the quantity of students passing their examinations from the schools, and thus gaining admission to universities and polytechnics. For instance, in 1993 when Kano was producing 1,092 top-flight scientists and engineers from universities, only 10.02% of 469 students in all the science schools obtained five credits in their results. This rose only to 16.4 (of 219) students in 1997.

Thus not only was there a decline in the quality of the results, the number of the students also seemed to be declining.

Research Questions

Specifically, this report therefore seeks to answer the following research questions:

1. What was the genesis of the Kano State Science Schools?
2. What was the mechanism of the Kano State Science Schools from 1977-1987?
3. What are the outcomes of the Kano State Science Schools from 1977-1987
4. What is the state of the project from 1988-1999?
5. What are remediative measures that can be taken to solve the problems?

Methodology

The two main methodologies employed in gathering information for this report. The first is documentary analysis. In this, I was given unrestricted access to all the internal *documents* of the Board which makes it possible to determine the full extent of the problem, linked by analytical insights. The documents include the series of reports written specifically to investigate the problems of the Science schools in 1998 and their follow-up. I was also given copies of most of the Annual Reports of the Board which enabled further information to be obtained.

The second methodology is *Focus Group Discussions* (FGD), a research methodology that sought same opinion from diverse group in a deeply probing manner. I held FGD with officials of the Board who were quite forthcoming about the problems facing the Board. Similarly, the teachers in the colleges, particularly Dawakin Kudu Science College (by far the most successful of the two schools) where I spent a whole day (11 a.m. to 4.40 p.m. on a Saturday) were quite frank about their limitations and perspectives for the future of the Colleges. In particular, the new Executive Secretary, Alhaji…. Was accessible, frank and willing to allow the problems of the Board to be discussed.

However the most insightful opinions about the state of teaching and learning in the school were given during an FGD with about 12 students at Dawakin Kudu, an in the absence of any of their teachers. We spent over an hour talking quite frankly about their teachers, lessons, feeding, physical facilities and other issues. All these informed my interpretation of the state of affairs in the colleges.

A basic limitation to the report is my main focus on *academic issues* and any student welfare issue that might affect their learning. Thus, due to the time limit (I was given only about ten effective working days to prepare the report) as well as its pilot nature, I did not delve into areas such as Board's funding, physical facilities, equipment availability, and teacher welfare. Ideally, it would have been desirable to see the teachers during actual teaching process, inspect the living quarters of the students, take a stock of the books available in the library, inspect teacher lesson plans and schedules. However, I believe that an indication has been given, both in the FGDs as well as the documents collected to support the interpretative nature of the learning process in the Colleges.

Genesis of the Kano State Science Schools

The early 1960s and early 1970s witnessed massive science education reform activities aimed at a more utilitarian interpretation of science education for pupils in both developed and developing countries. Two basic strategies can be identified. The first, which was predominant, focused attention on the nature of the science curriculum, and whose predominant theme 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 category of reforms occurred in both developed and developing countries such as Japan (Imahori 1982), Thailand (Sapianchia and Chewprecca 1984), Malaysia and Sri Lanka (Lewin 1980), Lebanon (Za'rour and Jirmanus 1977), Australia (Lucas 1972), Germany (Millar 1981), Holland (Hondebrink 1981), Malawi (Moss 1974), Nigeria (Ivowi 1982), and Canada (Ste-Marie 1982).

An added dimension to this strategy in both developed and developing countries (although more so in the latter), was an emphasis on an orientation to the labor market in some of the reforms, aimed at national self-reliance in scientific and technological disciplines through science education. This was inspired by the view that only a radical reform in science education could lead to national development and self reliance (Bude 1980; Commissiong 1979; Knamiller 1984; and Maddock 1981a).

The second science education reform strategy focused not on the science curriculum directly, *but on the improvement of the conditions of schooling aimed at achieving similar goals to the project-based curricular reforms*. This second approach, usually part of long term educational planning, was aimed at the continuous production of school leavers with positive inclinations towards science as a subject of study, and consequently as a career. Examples of this category of science education efforts included the Turkish Science Lycee (Maybury 1975), the Philippines Science Education Center (now the Institute for Science and Mathematics Education)(Maddock 1981b), The Fitz-mat Preparatory Science School in the Soviet Union (Baez 1976), and the Kenya Science Teachers College (Gumo and Kann 1982). But even in these *institutional reforms*, considerable attention is given to the curriculum in terms of its content, its nature, its philosophy and its overall direction.

In the light of all these, perhaps the ***weakest*** stone in the foundation of the Science Secondary Schools project in Kano was the fact that the project was determined directly by economic and political pressures, rather than by ***academic learning*** priorities. This was because the schools were primary conceived and created as means of counteracting the perceived lack of ***technological*** manpower in the development efforts of the state. As a Kano State Government report complained,

> "…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 1979 p. 43 and 139).

This is, for instance, reflected in the following table which shows the distribution of technological manpower in Kano State at the time the schools were conceived.

Table 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.

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 mechanism of the Kano State Science Schools from 1977-1987?

It was under this climate that in 1975 the Ministry of Economic Planning set up a Manpower Development Committee under the Chairmanship of Dr. Ibrahim Ayagi, an economist. 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).

As a consequent of its deliberations the Committee sent a memo to the Ministry of Education Kano suggesting the establishment of Science Secondary Schools as possible sources of technological manpower for the State in the future. 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[2]; 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 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)

In arriving at the decision to propose the establishment of the Science Schools as a longer term scheme for manpower production, the strategy sets a precedent in that it was the first of its kind in Nigeria. But interestingly, the Science Schools emerged not out of professional dissatisfaction with the science curriculum - which was a major reason for the large-scale science education reforms in many other countries in the 1960s — or the way it was taught, but with the political need to increase the output of students with extensive science backgrounds from Kano State.

[2] Quotations taken from an interview granted to Kano State CTV 67 channel by Dr. Ibrahim Ayagi and broadcast on February 2, 1986. Also based on a recorded and transcribed interview I held with Dr. Ayagi on January 7, 1987 in his residence in Kano.

Science, What Science?

Indeed, even the initial performance indicators of the Management Board established to look after the affairs of the schools merely stated that 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 Engineering (civil and mechanical), Agro-allied, food technology, lab technology fields, Health and Nursing care Health and Nursing care…" (Internal communication f the Board, 5th April 1984).

The main guide given to the interpretation of these aims was the Nigerian science curriculum. The Board religiously adhered to the interpretation of the curriculum, with all its attendant flaws, and relied on it as the main mechanism through which it can achieve these aims. This worked between 1977-1987 simply because buoyed by a large economic base and high policy prioritization, it was possible for the government in Kano to provide the necessary support for the schools to interpret the curriculum and produce its spectacular results. However, no attempts were made, either by the Board, or the schools themselves to go beyond the curricular rigidity as outlined in the WAEC syllabus. The scientific fare of the students was neither enhanced or enriched beyond the efforts made by the few first generation expatriate teachers of the schools.

But the issue of the science teaching emphasis in the schools still remained not addressed by the Science Board. As Dr. Ibrahim Ayagi explained when questioned on this,

> "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 maybe there were deficiencies in the teaching method. Maybe. 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, emphasis added)

I strongly believe it is this "shot-gun" approach that planted an inherent weakness of the science schools right from the beginning. This is because the

overwhelming focus of any science education reform strategy would be on attempting to inculcate the philosophy of science to students first and foremost, rather than focusing on examination results.

Failed Professionalization of Science Education

However, two attempts were made 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). 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." (CESAC to ES, Science Board, op. cit, emphasis added).

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, breakdown 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 communiqué 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' communiqué 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.

The ricochet of this approach also reflects itself subsequently in many way. The first set of teachers for the two science secondary schools were recruited from United States and Britain in the mid to late 1970s. These teachers were products of an increased world-wide movement aimed at radically altering the orientations of science teaching all over the world. By the mid 1970s science

has become a political issue, and the race for the supremacy of scientific development had dramatically shifted from congress and parliaments to classrooms across the world. The philosophy of science, in terms of what science should set out to do, rather than policy expectations of passing grade examinations, became the over-riding considerations in the teaching of science. Students are no longer seen as passive receptacles of knowledge, but as dynamic interactors with their learning and in most cases, being provided with the direct mechanism for controlling their learning — with the teacher merely as a guide and a facilitator.

Teacher Quality

While many countries in the world recorded different successes, the massive science education reforms of the 1960s and 1970s also reflect a general societal movement with greater reliance and dependency on science for its rationalism, and technology for its practicality. The teachers of the science secondary schools thus came to Kano (thanks to the powerful cajoling of Alhaji Ado Gwaram who led the recruitment team to Europe and United States) with the expectations of implementing a science with a definite philosophy and social orientation similar to what obtained in Europe. That this was not the picture they met on arriving to Kano.[3] 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 Qur'anic schools. Children see secondary school as an extension of the Qur'anic 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)

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 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

[3] I had an opportunity of discussing these initial problems with Terence Driscoll, a first generation teacher in the Dawakin Kudu Science Secondary School in 1987 at Sussex University, Brighton, England. Driscoll also gave me a copy of a socio-psychological report he wrote on the Dawakin Kudu Science Secondary School called *Dawakin Kudu Science Secondary School: An Institutional Analysis* which provided significant insights into the school in the early stages.

> 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 indigenous 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 2 shows.

Table 2: 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 2 was attributed to two direct reasons prevalent at the time. First was general welfare. Despite being established since 1977, the Science Board had 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 first generation of the schools from 1980-1986 was a massive success simply because of a series of factors, most notable was the "old guard" teachers, an aggressively honest selection process which ensured only the best students were admitted and the high publicity given to being a student in the Schools. This was because it suddenly became a status symbol for a student to be identified with the Science school — a process that to psychological problems for many of the students, leading to many riots and total breakdown of law and order in the early 1980s.

Student Quality

Under the standard procedure, students considered academically good in Form II (before the coming of the Junior Secondary Schools in 1982) 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 continued with Form III. In effect, the schools were therefore Senior Secondary Schools long before the secondary portion of the National Policy on Education became implemented in 1985. Tuition was totally free in the initial stage.

The Selection Examination papers were in Integrated Science, Mathematics and English Language. A student had to pass each at a level determined by the Science Board to be eligible for interviews, after which, if successful is placed in one of the Science Schools. Not all the Principals of the conventional schools were happy with this selection. As the Principal of a feeder school explained,

> Before the students were admitted, all of them had to go through rigorous selection examinations. There were two stages of the examinations. First the local examination set by the Board itself. Then the TEDRO (Test Development and Research Office) section of the WAEC (West African Examinations Council) 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. (CTV Program Transcript 27/2/1986).

Finally, all the Science Schools have eight science laboratories, two each for Biology, Chemistry and Physics, and one each for Geography and Technical Drawing. Subject choices in the schools are quite rigid. All the students must study Biology, Chemistry, Physics, Mathematics, English Language, Geography, and either Hausa Language or Islamic Studies (these being the only liberal arts subjects offered to them). In addition, the boys have a choice of one elective from Technical Drawing, Agricultural Science or Further Mathematics. Girls do not have these electives, although Food and Nutrition is a compulsory subject for them, and not offered to the boys. To compliment these facilities is a no expenses spared effort by the Science Board to recruit the most highly qualified science teachers for the schools — offering them totally different, and better, conditions of service from what obtains in the normal Ministry of Education secondary schools.

These conditions clearly made it possible for superior teaching and learning to take place. As a pointer, the following were the achievements of just one of the colleges, Dawakin Tofa from 1979 (barely two years after establishment) to 1987.

January 1979:	Islamic Studies Society of Kano Quiz Contest; 1st position November 1983: Young Scientists Quiz Competition (National Level held in Lagos); 1st position
April 1984:	Mathematical Association of Nigeria (MAN) National Quiz Competition; 2nd Position
November 1984:	National Young Scientists Quiz Contest, Kano State level: 1st position
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
May 1985:	Chemical Society of Nigeria, Quiz Contest Kano State level; 1st position
September 1985:	City Television (CTV) Schools Challenge; 1st position
October 1985:	Maths Quiz Contest, Federal Government College, Kano; 2nd position
November 1985:	Nigerian Television Authority Kano Quiz Competition; 4th position
January 1986:	Quiz Competition/Speech Contest of the Ahmadiyya Secondary School's 10th Annual Islamic Functions; 1st position. Won Trophy
March 1986:	Ahmadu Bello University Macroscope Science Quiz Contest; 1st position
May 1986:	Bayero University Kano Physics Festival Quiz Competition; 3rd position
May 1986:	Science Teachers' Association of Nigeria (STAN) Quiz Contest Bichi/Dawakin Tofa Zone: 1st position

June 1986:	Kano Educational Resource Centre "Science is Doing" Quiz Contest; 4th position
June 1986:	Young Brains - Nigerian Television Authority Kano Science Quiz Competition; 2nd position
June 1986:	STAN Quiz Contest Bichi/Dawakin Tofa zone; 1st position November 1986: National Young Scientists Quiz Competition Finals for Kano State; 1st position
December 1986:	National Young Scientists Quiz Competition Finals National level held in Kaduna; 2nd position
February 1987:	Muslim Corpers Association of Nigeria Islamic Quiz Competition; 1st position
March 1987:	Nigerian Television Authority, Kano "Science is Doing" Contest; 4th position
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 WAEC on 20th November 1984 at Abeokuta, Ogun State. In appreciation of his efforts, the school named its library building after him. Incidentally, 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.

What are the outcomes of the Kano State Science Schools from 1977-1987

The Schools 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*.

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. 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)

This still holds true of the science teachers in the schools. As most of the teachers are from southern part of the country, they consistently prefer Dawakin Kudu because of its proximity to the city hub (and the Board's Secretariat), and also because it is on a major exit from Kano to the south. This is strategically important as an escape route "in case of any *kata-kata*", as one of the teachers confided in me. Dawakin Tofa, being nested along a different axis is too insecure for them. Many teachers, after being posted to Dawakin Tofa on initial appointment, often request to be transferred to Dawakin Kudu. This partly explains why Dawakin Kudu consistently produces better examination results than Dawakin Tofa — they simply have more qualified, and stable cluster of teachers.

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 3.

*Table 3: Dawakin Kudu and Dawakin Tofa Science **Five Credit Level** GCE Ordinary Level Examination Results, 1980-1989*

	Dawakin Kudu			Dawakin Tofa		
Year	**No**	**Passed**	**%**	**No**	**Passed**	**%**
1980	98	37	37.75	85	12	14.11
1981	159	31	19.49	67	08	11.94
1982	151	37	24.50	157	27	17.19
1983	184	82	44.56	112	27	24.10
1984	205	65	31.70	169	32*	18.93
1985	213	95	44.60	236	65	27.54
1986	237	115	48.52	228	80	35.08
1987	229	78	34.06	208	87	41.82
1988	197	99	50.25	170	93	54.70
1989	221	98	44.34	212	54	25.47
Total	**1,894**	**737**	**38.91**	**1,644**	**485**	**30.0**

**The cohort the produced the best WAEC result in the whole country*

Summary, 1980-1989

School	No	Passed	%/Av
D/Kudu	1,894	737	38.91
D/Tofa	1,644	485	30.0

Total	**3,538**	**1,222**	**35.0**

Table 3 indicates many of the students from the two Science Colleges had obtained credit level results in the main subjects required for advanced study of scientific and technological disciplines, with an average credit level pass of 35%. While this itself is not high (an ideal would have been at least 45%), yet through these two schools alone, Kano was able to produced at least 3,538 high caliber science students between 1980 to 1989.

The 1,222 listed as having five credits were merely the most outstanding out of the lot; many others were qualified enough to be admitted into polytechnics, colleges of education to pursue different programs. It is on this basis that the earlier students of the schools were considered successful.

Labor 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, figures of graduating students made available to the Board by the Old Boy's Association of the Colleges (KASSOSA) showed the following pattern of graduation from key universities in the country, as shown in Table 4.

Table 4: Products from the Science Schools Students

Program	**ABU**	**BUK**	**UDS**	**UI**	**MAID**	**Total**
Civil Engineering	14	13	0	0	0	27
Chemical Engineering	25	0	0	0	0	25
Agricultural Engineering	23	0	0	0	04	27
Electrical Engineering	27	25	0	0	0	52
Building Engineering	13	0	0	0	0	13
Water Resources Engineering	14	0	0	0	0	14
Mechanical Engineering	15	26	0	01	0	42
Textile Technology	21	0	0	0	0	21
Biology	55	43	27	0	01	126
Chemistry	35	55	07	0	0	97
Physics	30	25	0	0	0	55
Computer Studies	05	0	25	0	0	30
Agriculture	51	0	0	0	02	53
Mathematics	28	39	0	0	02	69
Geography	18	08	0	0	0	26
Geology	15	0	0	0	01	16
Zoology	08	0	04	0	0	12
Statistics	03	0	0	0	03	06
Architecture	32	0	0	0	0	32
Pharmacy	64	0	0	0	01	65
Library Science	01	02	0	0	0	3
Veterinary Medicine	35	0	05	0	05	45
Human Medicine	64	18	06	04	0	92
Nursing	0	0	0	0	0	0
Others	32	35	16	04	18	105
Totals	**628**	**289**	**90**	**9**	**37**	**1,053**

(Source: Science and Technical Schools Documents)

Thus of the 1,053 graduates of the universities, at least 92 were medical doctors, 221 engineers, and 490 scientists. It is results such as these that point to the success of the schools in their first phase.

These represent only those whose whereabouts, as it were, were made available. This is because from Table 3, we have seen that the two schools have graduated 1,222 students with potentials for university study in the five most critical subjects — with a negligible loss of 169.

Science Forum 2000

Part Two

What is the state of the project from 1988-1999?

The schools were therefore as successful, despite massive educational and policy flaws in the beginning. The initial success can be attributed to purposeful teaching and learning and a solid foundation established by the pioneer teachers. However, the period from 1987 to 1997 was characterized by a progressive decline in the percentage number of students qualified for university entry. Many reasons were responsible for this. I will look at them in same pattern that I looked at the first stage of the project.

Administrative Overload

The Science Schools Board was changed to Science and Technical Schools Board in 1982 during the then brief civilian era. It was with the view that science and technology are related, therefore they should be under the same control. This was clearly a naïve view of science as well as technology. These two are not related, even in universities — Faculties of Technology exist separately from Faculties of Science, and with little interactivity. It is ridiculous to assume merely putting science and technical schools under the same administrative control will yield subject integration and interoperability. The consequence of this is that the Science Board became saddled with more schools, more responsibility, and little budget increase within a relatively short period of time. The table below shows the number of *science* schools under the Board's control since 1977

	School	**Year Established**
1.	Dawakin Kudu Science College	1977
2.	Dawakin Tofa Science College	1977
3.	Taura Girls Science Secondary School	1984 (Jigawa, 1991)
4.	Kafin Hausa Boys' Science Secondary School	1985 (Jigawa, 1991)
5.	Garko Girls Science College	1992
6.	}iru Girls Science Secondary School	1992
7.	Maitama Sule Science College, Gaya	1993
8.	Kano Day Science College	1993

It is perhaps not surprising that the first two, being the oldest and the only ones for as long as seven years, produced the best results (relatively). The rapidity with which new schools were established between 1992 and 1993 clearly showed the effects of political process on the system and lack of adequate and clear planning. The Kano Day Science College was established due to the high number of applications received from the Kano Municipal; so the Board decided to establish one day-release school to cater for this — further reflecting muddled planning.

To make matters worse, the Board established what it calls Consultancy Services Unit in March 1993 in order to generate more revenue which only aided in compromising the quality of attention given to the science schools.

The Board also became increasingly saddled with the responsibility of selecting students not only for its schools, but also for Rumfa College; Government Girls College, Dala; Government College, Birnin Kudu; and Kano Capital School. It is clear therefore that the extremely meticulous process adopted earlier in screening the students for the admission exercises could no longer be maintained due to the simply large number of students now involved for the selection exercise.

Subsequently, the attention of the Board became so diversified that it lacked a clear direction. This became much more clearer toward the middle 1980s and early 1990s.

An obvious first step, therefore, is to separate the science schools from the technical schools. The early schools were successful simply because there were only two of them. When they became four, the picture started getting complicated. It is clear therefore that the less, the better the quality of products.

Related to this is the issue of autonomy. Since the Board was still more or less an affiliate of the Ministry of Education, it was forced to source for money to keep afloat in the face of reduced government funding attributed to the recession that hit the county in the 1980s (itself a recipe for reducing the number of the schools under Board's direct control). Consequently it engaged in many commercial ventures such as utilizing the workshops and students of the technical colleges to rehabilitate furniture and other equipment. This took much of its time and reduced the quality of attention it can provide to its other schools.

A clear reduction of the number of schools is necessary to maintain the quality. The addition of Maitama Sule Science College, Kano Day Science College, and Garko Girls Science College all contributed to depressing the quality of the products due to diversified attention. I would strongly suggest that the Board concentrates on Dawakin Kudu, Dawakin Tofa and Garko as science colleges, and transfer the others to the Ministry of Education.

Quality of Students

A consequence of reduced funding is reflected in the students selection process. To begin with, all the students to the science schools from about 1982 were the UPE mass produced junior secondary school students with extremely poor background — being products of quantity, rather than quality. Whereas previously the students were from Form II of conventional secondary schools, now they are the half-baked products of the poorly implemented junior secondary schools. This was seen in the consistent way the students fail the English language examination which was used as the main basis for further selection. For instance, as a result of a consultant's report on improving selection and performance in English language, the Board introduced a two stage selection examination in 1990: the first was in English Language; only those who pass at the appropriate level can then sit for the next series of subjects that will determine eligibility to the Science Schools. Of the 17,000 who sat for this qualifying English examination, only 9,000 were able to pass enough to go to the next stage. It is not clear, in the light of the Board's sudden commercialization drive, whether this English Language qualifying examination is still as forcefully used.

Admission in the first cycle of the schools was based on merit. In the subsequent years it became a school-tie old boy network process where influential people bring their children and insist on them being admitted even if they did not pass (or take) the entrance examination. Further, the rigorous enforcement of selection process characteristic of the first generation life of the schools was discontinued; admission forms to the Science Colleges are simply taken to various schools for all and sundry to apply. Due to poor performance in English Language cut-off points were reduced to as low as 30% to ensure a spread in local government representation — necessary to entice the local governments to pay for the boarding fees suddenly introduced by the Board.

Thus the already bad situation was made worse in 1995 when the Board introduced _2,000 boarding fees. To enable students pay this, a formula was worked out where the Local Governments pay on the behalf of the students from their area. This eventually led to a situation where a quota system became surreptitiously introduced so that all local governments must be represented. Subsequently, some local governments stopped paying the money, and students whose fees have not been paid were simply rejected by the schools. In other words, the schools became more or less commercial.

Yet it is difficult to see where all the money collected went. In my Dawakin Kudu Student FGD, students complained bitterly of many things. Food was both non-nutritious, non-balanced, subsequently of poor quality and repeatedly insufficient quantity. Even then, it was not given at the proper times; for instance breakfast is usually taken at 10.30 a.m. Further, students complained bitterly of being given excessive labor duties — sweeping classes, compounds, cutting grass, etc. Since these are special colleges, and since they pay token fees, one would have expected an army of laborers to look after the school compound. All the laboring the students do take away the time they are supposed to spend on studying. There were also no sports and other recreational facilities (e.g. television).

I must say, however, that I was really impressed by the students I interacted with. They spoke their minds frankly and freely in excellent, lucid prose, the command of which was rather surprising for that level of education. One other point that stuck in my mind was their repeated disappointment with the cancellation of an ***exit*** facility. Without fail, they all expressed desire to be allowed to go home for at least one day during the weekends. I strongly suspect this is to escape the suffocating atmosphere of the schools (no water, no proper toilet facilities, broken down generators), as well as, in their view, the horrible food. Students pointed out that this was responsible for many of them sneaking out through the fencing (and thus risking the harsh punishment to follow) to town. Commendably, at least according to them, the school is drug-free; neither harboring dealers or users of even the common drug among adolescents, marijuana.

Curricular Provisions and Teachers

While the first generation teachers, being mainly expatriates trained in science teaching and exposed to then more popular advocacy of science teaching, the subsequent curricular provisions remained static and WAEC controlled, and the teachers became less qualified to teach science in the schools. Almost all the teachers have degrees in science, but they were not science teachers and clearly lacked the methodology to effectively teach science in the way

intended. Indeed teaching methodology of at least the Technical Drawing teacher was used by a Dawakin Kudu FGD participant as an example of poor teaching. The student actually took out his drawing book and showed me a series of concentric circles, telling me that they mean nothing to him, and that the teacher did not bother to explain what they are; all attempts to get the teacher to talk are rebuffed and met with severe punishment if the student persists.

In an ironic twist of fate, the Government's Appraisal Committee (Appendix 4) on noting the absence of quality control mechanism in the school, recommended that inspectorate duties should be performed by the KERDC. Yet in the first generation cycle of the schools, the teachers (mainly expatriate) kicked against allowing KERDC to do such job, and insisted on the establishment of an Academic Committee to do so. The fact that the problem has recurred indicate a clear lack of a monitoring mechanism that ensures correlation between what the teachers are doing and what the system expects them to do. The subject inspectors sent by the Board are mainly perfunctory in their inspections.

My day-long fieldwork tenure at Dawakin Kudu for the purpose of this report also enabled me to be closely acquainted with their library. Ironically, they have more chairs in the library than in Bayero University Main Reading Room library! However, most of the books are hopelessly outdated, and well worn out. It is clear therefore that both the teachers and the students lack effective reference materials. Students who cannot afford to buy any textbooks are clearly disadvantaged.

Teachers are therefore involved in a conventional teaching process which neither takes into consideration the student's ability banding, nor attempts enhance the curricular fare of the students. It is therefore imperative for the schools to introduce a series of *elective courses* (as would eventually be common in all the classes in the country, if the government accepts the recommendations of NERDC).

Examination Outcomes, 1980-1989

In using the examination outcomes of the science schools as benchmarks of their success, it is often overlooked that the overall results were not really spectacular, even in the halcyon days. For instance, both the schools performed dismally in 1981, in their second outing for the WAEC examinations, sending nervous signals to policy makers who stood by the project. At the same time, however, they perked up in 1988 during which they both scored over 50% examination success. Yet the Board did not seize this opportunity of analyzing the diary of events of that year to determine why there was such massive success.

A further analysis of the individual results reveal that, for instance, although D/Kudu scored a relatively 37.75% success rate in its first examination in 1980, it plummeted to 19.49% the following year. The highest achievements in the school were in 1988 when as many as 50% of the students scored five credits and above. Generally, however, the success rate of the school in the first cycle (1980-1989) was fair, averaging almost 39%. Dawakin Tofa, on the other hand, started off poorly and maintained that status for at least three years, perking up only in 1983 with a 24.10% success, although also plummeting down to 18.93

the following year. Its most spectacular mass achievement was in 1988 when about 54% of the students obtained the magical five credits and above. Overall, at only 30% average performance, it is clearly the weak link in the chain of success of the scientific manpower production in the state. Ironically, it was also Dawakin Tofa that produced the most outstanding WAEC record in 1984 when Aminu Abba (now a medical doctor) scored the highest results in the entire country — even though the overall performance of the school was quite poor compared to the previous year (or the next). To make it easier to see the trend of the results, I have re-arranged the examination outcomes according to highest number of students with five credits and more, as in Table 5.

Table 5: Halcyon-era Results, Dawakin Kudu and Dawakin Tofa, 1980-1989

Dawakin Kudu					**Dawakin Tofa**			
Year	***No***	***Passed***	***%***		***Year***	***No***	***Passed***	***%***
1986	237	115	***48.52***		1988	170	93	***54.70***
1988	197	99	***50.25***		1987	208	87	***41.82***
1989	221	98	***44.34***		1986	228	80	***35.08***
1985	213	95	***44.60***		1985	236	65	***27.54***
1983	184	82	***44.56***		1989	212	54	***25.47***
1987	229	78	***34.06***		1983	112	27	***24.10***
1984	205	65	***31.70***		1984	169	32	***18.93***
1980	98	37	***37.75***		1982	157	27	***17.19***
1982	151	37	***24.50***		1980	85	12	***14.11***
1981	159	31	***19.49***		1981	67	08	***11.94***
Total	**1,894**	**737**	***38.91***			**1,644**	**485**	***30.0***

However, as explained earlier, the 1980-1989 cohort were able to, by 1993, produce as many as 1,053 scientists, doctors, and engineers — the much needed manpower for technological development. Although up till now, about six years after their mass production, the state is still yet to develop technologically!! Clearly there is another magic ingredient needed for scientific and technological development of a society than simply having a large pool of scientific or technological manpower.

Of the original pool of schools, two which showed promise — a boy's school at Kafin Hausa and a girls' school at Taura — were consigned to Jigawa State, leaving Kano with the original two at Dawakin Kudu and Dawakin Tofa. Thus the late 1980s and early 1990s reflected a remarkable change in the fortunes of the science schools. The years became times of political considerations leading to more new schools being established at Gaya and Garko. The management of the Board became more commercial, charging, for the first time, considerable fees for Boarding, following the Kano State Government policy to deboard all its schools sometimes in 1993. Funding to the Board either became insufficient or was inefficiently utilized leading to reduced quality of instruction in the schools. The general social movement of austerity, economic crunch, embargo on jobs, etc all contributed to massive resignation of teachers — as many as 105 in the era — from the system. The result were reflected in the five credit success of the schools from 1990-1999 as shown in Table 6.

Table 6: "Apocalyptic" era Results, Dawakin Kudu and Dawakin Tofa, 1990-1998

Dawakin Kudu					Dawakin Tofa			
Year	***No***	***Passed***	***%***		***Year***	***No***	***Passed***	***%***
1994	121	56	***46.28***		1995	172	52	***30.23***
1996	125	55	***44.00***		1992	206	60	***29.12***
1990	189	75	***39.68***		1990	185	52	***28.10***
1992	200	73	***36.50***		1996	147	36	***24.48***
1995	170	58	***34.11***		1991	170	37	***21.76***
1998	166	55	***33.13***		1997	119	22	***18.48***
1991	186	46	***24.73***		1998	104	19	***18.26***
1997	98	14	***14.28***		1994	220	22	***10.00***
1993	219	23	***10.50***		1993	252	18	***7.14***

Surprisingly, just as in 1981 the two schools produced their worst results, a similar pattern is repeated in 1993 when the results of the schools were both less than 11% each. It is instructive that there was no single year during the 1990-1998 era in which any of the schools scored 50% in its results — disturbingly, it was only in 1994 and 1996 that Dawakin Kudu scored 46 and 44% respectively: the highest in the period.

Generally, however, Dawakin Kudu maintained its lead in producing consistently better results even in the "apocalyptic" years, although the highest produced was in 1994 with about 46.28% of the students obtaining five credits and above. The drop in the quality of results in this period was must faster than in the halcyon days, with the worst results being produced in 1993 at 10.50%. This is seen in the two summaries below:

Summary, 1980-1989

School	No	Passed	%/Av
D/Kudu	1,894	737	38.91
D/Tofa	1,644	485	30.0
Total	**3,538**	**1,222**	**35.0**

Summary, 1990-1999

School	No	Passed	%
D/Kudu	1,474	455	30.86
D/Tofa	1,575	318	20.19
Total	**3,049**	**773**	**25.35**

Thus Dawakin Tofa also maintained its second class position to Dawakin Kudu by producing increasingly depressing results, producing its highest result in the ten-year period only in 1995 at 30.23% — as compared to 54% in 1988. Perhaps it is the results of Dawakin Tofa that often raise the alarm of lowering quality of students in the Science Colleges.

There is a *clear drop* in performance between the two time clusters. From 1980-1989, Dawakin Kudu dropped from 38.39% to 30.86% average performance in examinations. Dawakin Tofa similarly dropped from 30% to 20% within the same period. Thus the overall performance of Dawakin Kudu in the nineteen year period was 35%, while that of Dawakin Tofa was 25%. By and large, however, in the almost twenty-year period, a total of ***6,587*** science students

were produced, with ***1,1995*** of them obtaining university level examination success, which represents about 30.28%, as reflected in the summary below.

Summary, 1980-1998

School	1980-1998		%	% of Total
Dawakin Kudu	3,368	1,192	35.39	18.09
Dawakin Tofa	3,219	803	25.0	12.19
Grand Total	**6,587**	**1,995**	**30.28**	**30.28**

Thus Dawakin Kudu has produced 18.09% of the total results in the almost twenty year period, while Dawakin Tofa produced only 12.19%. So why was Dawakin Kudu *consistently* better than Dawakin Tofa, especially as both apparently started from the same "level playing ground"? As noted earlier, although statistics have not been presented, but from FGD sessions with officials and teachers, it would appear that there is more high teacher quality presence at Dawakin Kudu than Dawakin Tofa, due to the former's relative proximity to the Kano CBD. And yet Dawakin Tofa is also located along a similar network, so that could not really be the total explanation. Another reason given for higher concentration of teachers at Dawakin Kudu was its proximity to a major highway linking Kano to the southern exit of the country. Since the history of Kano has been punctuated with civil disturbances, non-indigenes are happy when there is a possibility of an escape route nearby. Dawakin Kudu, located off Zaria Road, provides such handy exit point.

Conclusions

It is clear that the success of the science secondary schools in Kano has dipped; but not as dramatically as being made out. A more detailed study would need to be carried out to compare the performance of the students in all the science secondary schools in other states; as well a more information from the various higher institutions about the graduation rates of the students. Further, these results merely show those students with five credits and above; they did not indicate in *which* subjects the credits were obtained. For instance, credits in Islamic Studies, Hausa Language, English Language, Biology and Physics are commendable enough; but useless combination for a science career.

The seemingly poor performance of the students in the Science Colleges must be seen in light of previous achievements, but still incomparable with the performance of students in standard secondary schools. For instance, the results of the 1998 SSCE examinations in Kano revealed that only 50 students scored five credits and above — out of over 10,000 entrants; the Science Colleges among themselves alone produced 74 students with five credits in the same year .

Finally, therefore, *what made the Colleges successful in the first instance*?
It is quite easy to distill the reasons for the success of the science colleges in the first ten years of their establishment. These are all attributable to:

- sheer excitement at being a pioneer educational experiment — the *first* of its kind in the entire continent (the nearest to it is the Kenya Science Teachers' College)[4]
- high caliber staff with orientations and training in science education and aware of the purpose of science in development
- Board membership that provided excellent policy focus in line with development perspectives
- liberal fiscal policy that ensured regular supply of quality materials and equipment to the schools
- stringent student selection policy that ensured only the best entrants are taken to the science schools — regardless of social status
- virtual zero school fees charged on graded-scale linked to the child's socio-economic status; thus government subsidy enables bright children from poor homes to benefit from education in science.
- fewer schools, which means more attention to the individual units
- low development cycle: after the first schools in 1977, the next schools were established in 1984, and the next in 1992 — thus a gap of six to seven years in-between new schools. This provided sufficient time to study each school and attempt to replicate its success.

Conversely, the following might be *attributed to the downfall* of the schools in the last ten years:

- inept Board leadership
- increasing commercialization of science education in the state
- embargo on staff recruitment which made it impossible to replenish increasingly dwindling number of teachers
- inefficient Board Membership which lacks focus to provide effective guide to the matters of the schools
- lack of professionalization of the teachers, leading to stale and redundant teaching methodology
- political power-play which saw a rapid increase in the number of schools —two were created within just two years
- overburdened Board which had too many modules — technical schools, vocational centers, consultancy services unit, etc — to focus attention on each individual module effectively.
- compromising the student selection process which makes it now open virtually to any child whose Local Government council is willing to pay his _2,000 "boarding fees"
- dilapidated structures — such that the Board needed more than _10 million in 1999 to begin to set things right.
- prison environment for students who feel caged, with little poor quality non-nutritious food, lack of gaming and sports facilities, lack of basic amenities such as regular supply of water, and lack of leisure times and reading materials
- antiquated library stock that was more suited to 1960s rural English primary school than a millennium high caliber science facility

[4] Gumo, C and Kann, U (1982): *A Review of the Development of the Kenya Teachers College*. (Stockholm, Institute of International Education, Report No 61, University of Stockholm).

As indicated earlier, a more sustained and detailed study is needed to obtain the complete picture of the status of science teaching and learning in the Science Colleges. Nevertheless, as *a pilot study*, this report provides indications of the trends and patterns, sources of concern, and thus focus of action to bring about change. And it is quite clear that such change cannot be brought about by the government bureaucratic machinery. A pressure group, such as the Kano Forum, can effectively bring about change in many ways. I have carefully selected about 17 or so individual ways change can be brought about to improve the status of the science schools, but I have decided to put them in the Executive Summary of this report, rather than this conclusion.

Bibliography

Adamu, A. U. (1992) *Operation, efficiency and desirability of special science schools at the secondary education level: The Nigerian experience (1992)*: Paris: International Institute of Educational Planning, UNESCO.

Adamu, A. U. (1988) *Science, Schooling And Manpower Production in Nigeria: A Study of Kano State Science Secondary Schools, 1977-1987*. Unpublished D.Phil thesis, Sussex University, Brighton, England, 1988.

Aikenshead, G S (1984) Science Teaching at Prairie High School, in Olson, J and Russell, T (eds)(1984) *Science Education in Canadian High Schools Volume 3* Case Studies of Science Teaching. Ontario: The Science Council of Canada.

Baez, A V (1976) *Innovation in Science Education World-Wide*. Paris: The UNESCO Press.

Boud, D J et al (1985) The Physical Science evaluation, Western Australia 1978-79: An application of the illuminative model, in Tamir, P (1985)(ed) *The Role of Evaluators in Curriculum Development*. London: Croom Helm.

Bude, U (1980) Science Education Programme for Africa (SEPA) An Overview of Organization, Aim and Actions, in Bude, U (ed)(1980) *Science for Self Reliance*. The Science Education Programme for Africa. Koln: Deutsche Stiftung Fur Internationale Entwicklung; DOK 1050 A IT 21-05-80.

Commissiong, F (1979) Grade 10 and 11: *Science Curriculum in Jamaica. In Science Education for Progress - A Caribbean Perspective*. A Regional Conference, Barbados, West Indies 19-22 April 1979). London: International Council of Association for Science Education/ASE.

Dowdeswell, W H (1967) The Nuffield Project I: Biology 11-16. *The School Science Review* Vol XLVIII No 165 March 1967 pp 323-331.

Gatewood, C W and Osborn, E S (1963) Improving Science Education in the United States. *Journal of Research in Science Teaching* Vol 1 1963 pp 355-399.

Goodlad, J I et al (1966) *The Changing School Curriculum*. New York: The Fund for the Advancement of Science Education.

Gumo, C and Kann, U (1982) *A Review of the Development of the Kenya Teachers College*. Stockholm: Institute of International Education, Report No 61, University of Stockholm.

Harms, N C and Yager, R E (1981)(eds) *What Research Says to the Science Teacher. Volume 3.* Washington: National Science Teachers Association.

Hondebrink, J G (1981) Reform of Chemical Education in Holland. *Journal of Chemical Education* Vol 58 No 11 November 1981 pp 963-965.

Imahori, K (1980) Problems of Innovation in Japanese Science Education, in Adey, P (1980)(ed) *UK-Japan Science Education Seminar: Innovation in Science Education* London September 8 - 12 1980. London: The British Council/Chelsea College, University of London (Kings College - KQC).

Ivowi, U M O (1982) *Science Curriculum in Nigerian Secondary Schools* CESAC Occasional Papers No 4. Lagos: CESAC, University of Lagos.

Jackson, P W (1983) The Reform of Science Education: A Cautionary Tale. *Daedalus. Journal of the American Academy of Arts and Sciences* Vol 112 No 2 Spring 1983 pp 143-166.

Kano State (1970) *Kano State Statistical Year Book 1970.* Kano: Military Governor's Office, Economic Planning Division.

Kano State (1971) *Kano State Development Plan 1970-1974*. Kano State: Military Governor's Office, Economic Planning Division.

Kano State (1976) *Education Review Committee Final* Report (The Galadanchi Report), January 1976. Kano: Government Printer.

Kano State (1977) *Policy Statement 1977/78*. Kano: Government Printer.

Kano State (1979) *Ministry of Education Kano State: Progress Report, 1968-1979* Compiled by Alhaji Imam Wali. Kano: Ministry of Education, Directorate Division.

Kano State (1982) K.S. *Law No 10 of 1982: Science and Technical Schools Board Law, 1982* Kano State of Nigeria Gazette, Volume 16 No 11, 26th August 1982. Kano: Government Printer.

Kano State (1983) *Report of Committee on Problems and Prospects of Education in Kano State* (The Tijjani Isma'il Report). Kano: Institute for Higher Education/Kano State Polytechnic.

Kelly, P (1963) The Biological Sciences Curriculum Study. *The School Science Review* Vol XLIV No 153 March 1963 pp 312-323.

Knamiller, G W (1984) The Struggle for Relevance in Science Education in Developing Countries. *Studies in Science Education* Vol 11 (1984) pp 60-78.

Lazerson, M et al (1984) New Curriculum, Old Issues. *Teachers College Record* Vol 86 No 2 Winter 1984 pp 300-319.

Lewin, K (1980) Curricular Renewal and Examination Reform: A Case study from Malaysia. *IDS Bulletin May* 1980 Vol 11 No 2 pp 34-41. IDS: University of Sussex.

Lewin, K (1981) *Science Education in Malaysia and Sri Lanka: Curriculum Development and Course Evaluation, 1970-1978*. Unpublished D.Phil thesis, University of Sussex.

Lucas, A M (1972) ASEP - A National Curriculum Development Project in Australia. *Science Education* Vol 56 pp 443-451.

Maddock, M N (1981a) Science Education: An Anthropological viewpoint. *Studies in Science Education*, Vol 8, (1981) 1-26.

Maddock, M N (1981b) Science Education in the Philippines - The decade of the 1970s. *Search*, Volume 12 No 8 August 1981 pp 253-259.

Maybury, R H (1975) *Technical Assistance and Innovation in Science Education*. New York: Science Education/John Wiley.

Millar, R H (1981) Science curriculum and social control: a comparison of some recent science curriculum proposals in the UK and the Federal Republic of Germany. *Comparative Education* Vol 17 No 1 March 1981 pp 26-46.

Moss, S (1974). Biology Curriculum Development in Malawi. *Journal of Biological Education* Vol 8 No 1 1974 pp 20-31.

Nigerian Educational Research Council, NERC, (1985) *National Curriculum for Senior Secondary Schools* Reproduced by Kano Educational Resource Centre, Kano - A. Biology, B. Chemistry, C. Physics. Kano: K. E. R. C.

Orpwood, G W F and Souque, J (1984). *Science Education in Canadian Schools. Summary of Background Study 52*. Ontario: The Science Council of Canada.

Sapianchai, N and Chewprecca, T (1984) Implementation of Thai High School Chemistry Curriculum. *Journal of Chemical Education* Vol 61 No 1 January 1984 pp 44-47.

Ste-Marie, L (1982) Science Teaching at the Secondary Level: An Evaluation, In *Quebec Science Education: Which Directions?* The Proceedings of a symposium sponsored by the Science Council of Canada and l'Association des professeurs de sciences du Quebec, March 1982. Ontario: The Science Council of Canada.

Tisher, R P et al, (1972) *Fundamental issues in Science Education*. Sydney: John Wiley and Sons Australasia Pty Ltd.

Waring, M (1979) *Social Pressures and curriculum innovation - A study of the Nuffield Foundation Science Teaching Project*. London: Methuen.

Williams D H (1960) *A short survey of education in Northern Nigeria*. Kaduna: Government Printer, Northern Region.

Za'rour, G I and Jirmanus, R (1977) SCIS in a Lebanese School. *School Science and Mathematics* Vol LXXVII No 5 May-June 1977 pp 407-417.