DOCUMENT RESUME

ED 389 688 SP 036 332

AUTHOR Bajah, S. T.
TITLE Shortage of Science and Mathematics Teachers: A Nigerian Case Study. Science, Technology and Mathematics Education.
INSTITUTION Commonwealth Secretariat, London (England).
PUB DATE 93
NOTE 72p.; For related reports on Quality in Basic Education, see SP 036 329-334.
AVAILABLE FROM Commonwealth Secretariat, Education Programme, Human Resource Development Group, Marlborough House, Pall Mall, London, England SW1Y 5HX, United Kingdom.
PUB TYPE Reports - Research/Technical (143)

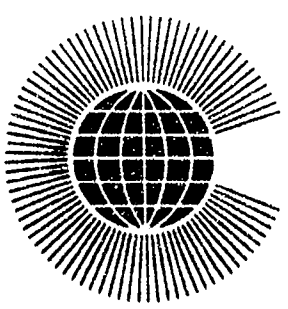
EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Case Studies; *Curriculum Development; Developing Nations; Educational Policy; Elementary Secondary Education; Faculty Development; Foreign Countries; Higher Education; *Inservice Teacher Education; Mathematics Curriculum; *Mathematics Teachers; Preservice Teacher Education; Science Curriculum; *Science Teachers; Standards; *Teacher Education Programs; Teacher Effectiveness; Teacher Improvement; *Teacher Shortage; Teacher Workshops
IDENTIFIERS *Nigeria

ABSTRACT

This report is a case study of the shortage of science and mathematics teachers in Nigeria. The paper begins with a discussion of the Nigerian educational system, including the place of science and mathematics in the school system, and the shortage of science and mathematics teachers. Programs undertaken to increase the number of science and mathematics teachers and the program outcomes are described. These include: a regional crash program for training Junior Science Masters; establishment of a national Emergency Science School to prepare sixth form students for university education; the Universal Primary Education (UPE) program, UPE teaching training institutions; Sandwich Associateship Programmes in University Institutes of Education; creation of special science schools in the states; introduction of remedial science programs at some universities; the "Winning More Students for Science" Program at Lagos State University; and several inservice training programs throughout the country. Also described are activities and products of a May, 1992, Regional Workshop in Science, Tecnnology and Mathematics Education in Nigeria organized by the Commonwealth Secretariat. Statistical graphs are included in appendices. (Contains 10 references.) (ND)

Science, Technology and Mathematics Education

Shortage of Science and Mathematics Teachers: A Nigerian Case Study



Commonwealth Secretariat
1993

SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION

SHORTAGE OF SCIENCE AND MATHEMATICS TEACHERS: A NIGERIAN CASE STUDY

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Commonwealth Secretariat
1993

COMMONWEALTH SECRETARIAT

Education Programme
Human Resource Development Group
Marlborough House
Pall Mall
London SW1Y 5HX

First published 1993

Copies may be obtained from the Education Programme,
Commonwealth Secretariat.

C O N T E N T S

Acknowledgement

The challenge to undertake this study came from Mr Jakes Swartland, Assistant Director, Education Programme of the Commonwealth Secretariat.

Assistance in information gathering was readily given by the following:

- Professor P Okebukola, Dean, Faculty of Education, LASU
- Mrs Cecilia Pwol, National Treasurer of STAN
- Mr Ben Ben Akpan, Administrative Secretary of STAN
- Dr G E Nwankpele, Deputy Director, Science Education, (Federal Ministry of Education)

Converting empirical information into graphical form was possible through the help of Dr Siyan Malomo of the Commonwealth Science Council.

Typing of the manuscript was painstakingly done by my Secretary, Miss Annie Kahenya.

However, any expressions of opinion in this publication are those of the author and not necessarily those of the Commonwealth Secretariat.

P R E A M B L E

The main focus of this study is the important problem of **shortage of science and mathematics teachers.** In addressing that problem, it was necessary to also examine the popularity and hence the enrolment of students in science and mathematics as school subjects. Adopting that stance pre-supposes that there is a causal link between student enrolment and shortage of science and mathematics teachers. Across Africa, science and mathematics have received special mention in policy documents on education. If indeed there is shortage of these teachers, then the prevalent education policy along with intervention programmes need to be re-examined, which is what has been done in the study with particular reference to Nigeria. Based on that premise, some far-reaching recommendations have been made to overcome the shortage. The need to increase and control the investment on human and material resources for science and mathematics have been underscored in this study.

STUDY ADDRESSING THE SHORTAGE OF SCIENCE AND MATHEMATICS TEACHERS: A NIGERIAN CASE STUDY

Background

This paper deals with a Nigerian Case Study and so it is pertinent to introduce it with the educational system. The development of education in Nigeria is guided by a **National Policy on Education** (NPE). First published in 1977, the NPE was revised in 1981 to herald and underscore the present educational system which is commonly referred to as the 6-3-3-4 system. The system is organised into six years of primary education, three years of Junior secondary (JS) education; three years of senior Secondary (SS) education and four years of tertiary education. Figure 1 shows the 6-3-3-4 Education system in schematic form including chronological age and grade level (Onwu, 1992).

The Place of Science and Mathematics in the School System

Both before and after independence, science and mathematics had been regarded as priority subjects in the Nigerian school system. Before independence (October 1960), the science taught in Nigerian primary schools was Nature Study - rudiments of science in the environment with emphasis on plants and animals. Nature study as a basic science had its short-coming and so immediately after Independence at the National Curriculum Conference (1969) Basic Science was substituted for Nature Study. (Bajah 1989).

Basic science at the primary school level in Nigeria is classified as a core subject. The Federal Ministry of Education organised science educators who are curricul ٦ developers to

produce what is now referred to as the **Core Curriculum for Primary Science CCPS**, published in 1980. In that document, the objectives of primary science were listed as helping the child to:

(i)	**observe and explore the environment;**
(ii)	**develop basic science process skills**
(iii)	**develop functional knowledge of science concepts and principles;**
(iv)	**explain simple natural phenomena;**
(v)	**develop scientific attitude including curiosity, critical reflection and objectivity;**
(vi)	**apply the skills and knowledge gained through science to solving everyday problems in the environment;**
(vii)	**develop self-confidence and self-reliance through problem solving;**
(viii)	**develop a functional awareness of and sensitivity to the orderliness and beauty in nature.**

Table 1 provides some statistical information about primary school education in Nigeria. At the junior secondary level, a national initiative gave rise to the publication of a **Core Curriculum for Integrated Science** (CCIS), published in 1980 by the Federal Ministry of Education. Eight objectives were identified in CCIS.

- observing carefully and thoroughly;
- reporting completely and accurately what is observed;
- organising information acquired;
- generalising on the basis of acquired information;
- predicting as a result of generalization

- designing experiments including controls where necessary to check predictions;

In a study (Akpan 1983), the objectives of integrated science were condensed into three:

1. **gain the concept of the fundamental unity of science;**
2. **gain the commonality of approach to problems of a scientific nature;**
3. **gain an understanding of the role and function of science in everyday life and the world in which we live.**

Integrated science was approved as the science to be taught in lower secondary schools. Table 2 provides some statistical information about secondary school education in Nigeria.

Mathematics like science has also received maximum attention in the curriculum development efforts. Mathematics is one of the core subjects at the primary school level (i.e. all pupils compulsorily offer mathematics) and at the secondary school level. In a majority of the primary schools in Nigeria, mathematics as taught by generalist teachers who teach all subjects while at the secondary level, specialist teachers teach mathematics.

Under the auspices of the Federal Ministry of Education, the mathematics core curriculum for both primary and secondary school education have been published and used.

Shortage of Science and Mathematics Teachers

For a country with well-conceived national curriculum guidelines put in place and with a primary school population of about 13 million pupils, with rich mineral and agricultural resources, shortage of manpower of any kind among the 88.5 million inhabitants raises a good deal of concern. Perhaps one can approach the problem and ask a direct question "Is there a shortage (at the basic level) of science and mathematics teachers in Nigeria?" If the answer to the question is in the affirmative, then one can further ask about any national efforts that are in operation to address the issue of shortage of science and mathematics teachers. And finally, how successful have these efforts been?

The problem of shortage of science and mathematics teachers may have its roots in a number of issues especially in student enrolment, student performance, and graduate out-put in the disciplines of science and mathematics. In a recent Report by the National Universities Commission, NUC, (Abdulkadir, 1992), some allusions were made to the problems facing the science discipline.

> "Nigerian universities [30] are together producing an average of 3,245 science graduates annually. Currently, the average intake into the programmes in the science discipline is 3,602. The required manpower needs in science has not been achieved despite this tremendous leap. Hence, a lot still needs to be done to meet the manpower requirement for scientists in the labour market".

It was not, immediately possible to deduce necessary information about shortage of science and mathematics teachers from a

statement such as the above, although it is a well known fact that if enrolment and graduate output are acute in the science education discipline, it would be worse in the science education discipline. It was going to be a Herculean task, given the conditions under which this Report is being produced, to attempt to obtain direct empirical information on shortage of science and mathematics teachers at the national level. We therefore decided to take a sample state and critically study the shortfall of science and mathematics teachers. Hopefully, we can thereafter project to the national level. Figure 2 provides statistical information on the shortfall of teacher requirement in a state, with a total of 679,706 pupils in the primary and Junior Secondary classes, (basic level). **Mathematics has the highest shortfall of 163 teachers.**

The admission of students into the university to read science and/or education is a major factor in the output of science and mathematics teachers. While Tables 1 and 2 provide some empirical information of education in Nigeria, Figures 3 and 4 provide in a very general way, the **profile** of admissions into two universities in the disciplines of Natural Science, Social Science and Education. In both figures, admission into social science is highest. The effect of such a trend on university output is obvious - less graduates of science and science education available.

Then there follows another relevant question - why is admission into the natural science and education lower than into social sciences? To address that question, we took a close look at

performance of students at the end of their secondary education in six science/mathematics subjects - **Agricultural science, Biology, Chemistry, Physics, Mathematics and Technical Drawing,** (Tables/figures 3-8), over the period 1981 to 1991. A close look at the performance trend shows that on the average, only about 20% of those who enrol for the examination in the science subjects attain the grade of 1-6. The grades which are acceptable for university admission are grades 1-6. Although grades 7 and 8 are pass grades, universities do not consider them high enough for purposes of admission. So one implication of that kind of policy decision is that we do have a large pool of would-be science bound students to draw from **in any remedial programme.**

The arguments put forward so far attempt to show that within the school system in Nigeria, there is comparatively low out-put of science/mathematics students. The result is that admission to the university profile shows more intake into the non-science/mathematics discipline. Thus the out-put of science/mathematics graduates is bound to be relatively lower than in social sciences. We then have a vicious cycle whose narration will be incomplete if we do not address the reasons for the low enrolment, low performance and low out-put of science and mathematics graduates, for those too are part of the problem. We shall return to the vicious cycle later on.

We studied transactions in some schools to find out how students respond to science and mathematics relative to the other school subjects. Figure 5 shows students' preferences for some selected

school subjects. It is interesting to note that the students surveyed have high preference for mathematics and science than for social science and fine art. Among those who claim to have low preference for science and so would not offer these subjects if they are given a choice gave three compelling reasons (Figure 6).

- examination policy (55,6%)
- no qualified teacher (38.9%)
- university requirement (5.5%)

Of the above three, the one most relevant to the subject under study is "no qualified teacher". Even students are able to make judgment about the qualification of their teachers.

The argument so far point in the direction of shortage of science and mathematics teachers in Nigeria. Both quantitatively and qualitatively, there is need for something to be done to raise and improve the quality of science and mathematics teachers. The remaining part of this study will present information on actions taken to overcome the shortage of science and mathematics teachers.

Actions taken to increase the out-put of science and mathematics teachers

In tackling this aspect of the study, it is pertinent to look at the chronological actions in three stages:

(i) Immediately before and after political Independence

(ii) The financial boom years of University primary Education (UPE)

(iii) After the introduction of the 6-3-3-4 Educational system.

Immediately before and after Political Independence

Immediately before and after the 1960 political independence, a number of the expatriate including teachers of science and mathematics left the country. The shortage of mathematics and science teachers reached a disturbing level to the extent that government declared a national crisis with respect to availability of the teachers. Several discussions, conferences and study groups were held to offer some suggestions to alleviate the crisis of the shortage.

It was clear that shortage of indigenous science and mathematics teachers had its roots in insufficient enrolment and sustainability in the two subjects. With poor enrolment in the subjects at the primary and secondary levels, the number of students who entered tertiary institutions to offer the subjects was adversely affected. And with very low enrolment in tertiary institutions for science and mathematics, there was the concomitant shortage of those with such background who ventured into the teaching profession. Thus a vicious cycle evolved with poor enrolment at one level affecting the output at subsequent levels. This observation in Nigeria was not peculiar to the country as many other countries, suffered the same fate.

Arising from the observations, government promulgated a number of national education policies to combat and redress the shortage of science and mathematics teachers. Such policies included:

(i) a crash programme for Junior Science Masters at regional level;

(ii) the establishment of a national Emergency Science School at the then Federal Capital (Lagos).

Regional Crash programme for Junior Science Masters

An experiment in creating a mass of trained Junior Science Masters was started in the then Western Region of Nigeria. The Chief Inspector of Schools for Science organised a six-months crash science and mathematics programme for the training of teachers who teach the subjects at the lower secondary level. The Ministry of Education sent out circulars to all the secondary schools in the region to nominate two teachers each who are on their staff, teaching science or mathematics and also have not been formally trained as teachers. The schools were to arrange to transport the teachers to the regional capital and from there on, for six months, the Science Division of the Ministry of Education took over. One incentive was given to these teachers - their normal salary was being paid back in their schools; but they were also given financial support as allowances by the Ministry of Education sufficient for their feeding and modest accommodation. The condition for nomination to the programme was a Cambridge School Certificate with at least a credit, not a pass in one science and mathematics subjects. Since at the junior secondary level, the science taught was 'General Science', a credit in any science subject (biology, chemistry, physics, General Science or Physics-with-Chemistry) was considered adequate. There was to be an intake of 30 half yearly for the four years the programme was to run. The programme for the

Junior Science Masters Course consisted mainly of:

- revision of Cambridge School Certificate science and mathematics content as laid down in the overseas syllabus; [2 hours];

- practical work and improvisation techniques [2 hours];

- use of English language for communication [2 hours].

The daily programme ran from 8 a.m - 12.00 p.m.' 2.00 - 4.00 p.m. The trainees were supplied with the UNESCO Source Book for Science, and a number of other textbooks. The trainees were kept busy with daily homework/assignments which were religiously done, marked and discussed in class. The trainees were taken through the General Science Syllabus content where they were treated like students. Then in practical work the trainees were taught how to make simple basic science apparatus which the teachers were encouraged to take back to their schools. The Ministry of Education provided all the necessary materials for fabricating the science apparatus. One significant aspect of the programme was the fact that teaching methodology/psychology, etc. were not taught as such, but science and mathematics were taught in a model way. In retrospect, after the six months, the trainees were so enthused that they immediately formed a solid foundation of good junior science and mathematics teachers who:

(i) were competent in thee subject content in science and mathematics at the junior secondary school

level as prescribed in the syllabus;

(ii) punctuated their teaching with practical hands-on activities;

(iii) had very strong academic background in English, Science and Mathematics, subjects which they could offer at the University entrance examination.

As was later on found, the third factor formed a major incentive for people wanting to take the course offered to junior science masters. While the course produced a solid group of good science and mathematics teachers, it also offered some hope that they were not pursuing a dead end as far as their career was concerned. The evaluation which was carried out on the programme for Junior Science Masters in Western Region of Nigeria (1958-62), claimed success for the programme in the region. All the then secondary schools in the Region had on its staff, at least one science and/or mathematics teacher who had undergone the course. Those who took the entrance examination to the University College Ibadan from that group of trained teachers went on to take a science or mathematics degree and many returned to the classroom this time as Senior Science Masters, with teaching qualification.

The lesson learnt from this Regional Programme was that both the quantity and quality of Junior Science/Mathematics teachers can be improved by a Ministry of Education. The Ministry provided the staff who taught in the course from their pool of highly

qualified personnel. Trainees interest in science/mathematics can be sustained even after additional academic qualification. What was important was that the intervention by the Regional Ministry of Education filled a gap which hitherto would have been very difficult to fill without intervention from outside the country i.e. importation of expatriate teachers. Improving the quality of science/mathematics teaching in the region at the basic level by **institutionalising** a training programme with proper academic/professional certification did help to reduce the shortage of science and mathematics teachers in the Region. The drive and initiative of a Chief Inspector of science in the region has been quoted as an example of positive action to tackle a prevalent problem. That singular example was quoted as one of the incentive which led to the creation of an Emergency Science School at the national level.

Establishment of a national Emergency Science School

The importance of science and mathematics had been highlighted in public statements. The shortage of graduates was predicted before and immediately after political independence. Initiatives and experiments have been tried at regional and local levels. Now there was a need to tackle the problem of shortage of science and mathematics teachers at the national level. The expansion of universities also placed an added demand and applicants with sufficient background qualification to fill university places in science and mathematics were in short supply. The result was that about two thirds of those admitted to universities were non-science students.

Admission into the various universities went through one of two routes - either by attaining at least two A-level passes at the Higher School Certificate (Sixth Form) College or by attaining two A-level passes at the General Certificate Examination (GCE). It was a straight jacketed route - either you fit in or you are out. But the Sixth Form Schools were not providing enough qualified candidates for the universities for two reasons:

(1) The sixth-form schools were not sufficient in number for the school population;

(2) Results especially in Science and mathematics were poor (less than half of all the students attain university matriculation grade).

And the performance of the students in the sixth-form schools were poor because of inadequate laboratory facilities and poor human resource (teachers and laboratory technicians). For a long time, sixth from schools became liabilities especially for science and mathematics. There was therefore talk of re-modelling them or scrapping them altogether. But meanwhile, there was a large number of unqualified sixth-form graduates all over the country. It was to overcome all these problems that a special **Emergency Science School** was established. Most of the intake were those who having failed out of Sixth Form schools still wanted to pursue a science-related or mathematics course. They were in desperate hurry. Thus the only national Emergency Science School was founded in the then Federal Capital (Lagos) in the early sixties.

The Emergency Science School had certain peculiarities which made it unique in the country:

(a) The staffing of the Emergency Science School was centrally coordinated and good sixth-form science and mathematics teachers drawn from schools around the country were picked and appointed to the school. They were given a condition of service much better than their counter-part in the then existing Sixth-Form schools. Additional staff were recruited on part-time basis.

(b) The Emergency Science School was given the responsibility to teach six subjects:

1. Biology
2. Zoology
3. Botany
4. Chemistry
5. Pure Mathematics
6. Applied Mathematics

The main purpose was to prepare their students for the GCE A-level examination in one or more of the above subjects. The flexibility of allowing students to enrol for one or more subjects made it possible for applicants to satisfy their needs. For instance those who had attended Sixth form schools and passed only one science/mathematics subject at A-level could register for one more or two subjects to qualify for university admission. It was clear from that policy that all those who attended the Emergency Science School were University bound. Thus attrition and drop-outs from the main stream of science/mathematics was rare.

(c) The laboratories in the emergency Science School were well-equipped for A-level work with the compliments of trained laboratory Assistants, some of who also registered for the A-level examination in science/mathematics.

(d) The programme of teaching was to run from 8 a.m. till 10 p.m. something which did not exist in the conventional sixth-form schools. The Emergency Science School was thus like a 'factory' where along the conveyor belt, the much needed science/mathematics student is produced to desired shape. With a programme such as this, the Emergency Science School admitted a large number of students - over five hundred at any one given time.

(e) The emergency Science School made provision for part-time students who went to work during the day and attended classes during the night and week-ends. That also made for part-time teachers.

(f) The overall Director of the Emergency Science School was a former distinguished science teacher who had risen to the rank of a Director-General (Permanent Secretary) in the Ministry of Education. With a Director of such a status, the Emergency Science School was given a high profile and such a Director had easy access to his colleagues in the Ministry of Education. By appointing such a highly placed Director, it was clear that the Government meant real business and so gave science/mathematics a high status, an important ingredient in a programme such as this.

Outcome:
The success of the Emergency Science School was resounding in the country. The number of students who qualified to enter the universities for science/mathematics courses increased. The Emergency Science School produced more science/mathematics A-level candidates than all the then existing sixth-form schools produced. One out of every three students who were enrolled in the universities in Nigeria for science/mathematics courses had a stint in the Emergency Science Schools. Because of the good science/mathematics background which the Emergency Science School gave their students, the drop-out rate after entering university was negligible. The Emergency Science School in Lagos did what no other programme had done to combat the shortage of science/mathematics students in Nigeria. The Emergency Science School is indeed a success story.

In Retrospect

The experiment at the Emergency Science School in retrospect, must have been responsible for the evolution of special science/mathematics schools in the other regions of the country, an experiment which is still going on even in 1993. Also, the abolition of the conventional sixth form schools in the country in the late eighties must have been done with confidence in the success of concentrating efforts in the production of would-be entrants into Nigerian universities. And the transformation which has taken place in the Emergency Science School, first to Federal Science School (FSS), then to the present Federal School of Arts and Science (FSAS) leaves one with the impression that Government still wanted to keep the spirit of the Emergency Science School.

The Financial Boom Years of the Universal Primary Education (UPE)

In 1976, the then Head of State announced the intention of Government to introduce the Universal primary Education, a

programme which guaranteed any child of School age, a place in the nations school. Although the programme was styled 'universal', Government was cautious then not to make it "compulsory universal primary education", for the implication of that would be far-reaching. Even then, that approach in the educational system brought before the gates of the existing primary schools an overwhelming number of children asking for primary education. Not only was there a shortage of infra-structural facilities, but also an acute shortage of primary school teachers to service the huge number of children of primary school age.

In tackling the problem of shortage of teachers, Government went all out to recruit staff from within and outside Nigeria. It was said then, meaningfully but which proved unfortunate, that the country was rich, so rich that money was then not the problem but how to spend it. As far as UPE was concerned, money should not be the limiting factor. So recruitment of staff into primary schools could be done from anywhere. Later, that policy had very adverse implication for the management of primary education in the country.

Furthermore, science and mathematics became core subjects in primary schools and it was found, sadly though, that many of the primary school teachers did not have either the academic background nor the confidence to teach science, especially the sort of science demanded by the National Policy on Education. There was abundant evidence to show that although there was a phenomenal increase in teacher recruitment, there was a

significant shortage in staggering numbers of those who could confidently teach science and mathematics (but science in particular). To overcome such and other relevant problem, several strategies were used two of which are discussed in this study.

Setting up of UPE Teacher Training Institutions

The Federal Government after 1976 set up in the various states, institutions for **up-grading** and **up-dating** teachers who would be recruited into the UPE schools as they were then styled. These institutions received direct government subsidy and those admitted into them were given certain incentives like no tuition fees, generous financial allowance and supply of necessary books, and materials.

With particular reference to science, there was an almost open-door policy of admitting students from the secondary schools. Those who have literally failed to obtain the basic five credits to qualify to apply for university entrance examination and those who did take science but failed to obtain enough credits to meet the minimum entrance requirements of the universities qualified to be admitted to the UPE teacher training institutions. Some of the would-be science - trained primary school teachers from the programme were those who failed science at the School Certificate level (O-level).

The programme of instruction followed the conventional programme of Grade Two (Grade II) teacher training. the institutions were located in old grade II teacher training Colleges and were run

like conventional schools. The programme lasted for between 1 year to 4 years depending on the academic background of the students prior to entry.

Outcome

There were initially great expectations from this experiment and an appreciable number of teachers were trained. But as far as science and mathematics were concerned, the impact in arresting the shortage of such teachers was not significant. The UPE schools are no more in existence in the country.

Sandwich Associateship Programmes in University Institutes of Education

With the UPE boom programme, the country produced a large number of Grade II teachers, this time most of them indigenous. Most of these teachers with long years of service (10 years on the average) reached stagnation and frustrated with their inability to cope with the demands of the new primary school curriculum especially in science and mathematics. Institutes of Education in a number of the universities then mounted special up-grading programme for that group of teachers. Special effort was made to offer science and mathematics as core subjects for the teachers in an attempt to combat the shortage of teachers of the subjects. The programmes was conducted for one calendar year making use of the weekend, short and long vacations in the universities. While the programmes succeeded in upgrading the Grade two teachers to Grade One teachers with implications for five grade levels up in their salary structure, it contributed only in a minimal way in

addressing the problem of shortage of science and mathematics teachers. The up-graded teachers returned to their schools seeking higher positions (senior teachers and head teachers).

Outcome

This programme succeeded in up-grading teachers to Grade One Since the pool of trainees came from those who were already Grade Two teachers the over ten years during the life of the programme succeeded in up-grading the available Grade Two teachers. Now there is a dearth of such teachers needing up-grading. But the problem of shortage of science and mathematics teachers in primary schools still remained.

After the introduction of the 6-3-3-4 educational system

When the National Policy on Education (NPE) was revised in 1981, it drew special attention to the 6-3-3-4 Educational System and to the need to follow the guidelines in the national curriculum which were described as the **core Curriculum**. The significance of science and mathematics was again underscored. Also, the phenomenal expansion of university education with now a total of thirty-one (31) universities in 1992 called for greater intake from the pool of secondary school leavers. Three programmes which contributed positively to an attempt to combat the shortage of science and mathematics students/teachers are described here.

The creation of special Science Schools in the States

As discussed earlier in this study, the experiment with the Federal Emergency Science School and its impact did not go

unnoticed. With the strong demand from the universities to state Ministries of Education to fill both their allotted quota in the admissions and especially to fill the science quota, there was need to do something radical. The Federal Government had by this time drawn the attention of the National Universities Commission (NUC) to advise the universities to adhere strictly to the 60:40 admission policy. **The 60:40 admission policy specifies that 60% of University admission are to be reserved for science related subjects while the remaining 40% was to be reserved for non-science.** As the universities enforced this policy, it became clear that science students were not forthcoming to fill their quota and the situation varied from state to state.

Some states, somehow classified as 'educationally deprived' found it even harder not only to certify enough students to take up University places allotted to them but also to meet the 60:40 ratio of science to Arts. The need therefore to create and fund **special state science schools** arose to overcome the shortage of science students. The special science schools had the semblance of the original Emergency Science School - attracting well qualified science and mathematics teachers with additional incentives, extra-ordinary material resourcing of the science schools; and special rigorous selection of students into the schools. While the schools adopted the conventional modality, it placed particular emphasis on science and mathematics to the extent that **all the students were science or mathematics**

bound. Unless the student had decided to pursue a career in science or mathematics on completion, there would be no admission into the special science schools.

The success of the science schools in the state which initially adopted this modality was resounding. Over a short period of three-five years, the state was shot into prominence by the performance of their students in the national O-level examination. Students from the special science schools came tops in the sciences and performed reasonably well in the overall examination. Not only that, the state was able within that period to meet their quota in the 60% science admission requirement to universities. The special science schools immediately got the attention of other states and the idea spread. By the end of the eighties, special science schools were being opened in schools across states in the country. Again, the experiment was a success and states that adopted the experiment will hopefully be able to meet their demands in science in terms of availability of students.

When this experiment is extrapolated across board, it can be claimed that it did respond positively to the issue of shortage of students. From there it is natural to expect that with the phenomenal increase of science and mathematics students, there will be corresponding increase in the number of those who go on to train as science and mathematics teachers.

The lesson to be learnt from the experiment with special science schools is obvious. When the scarce resources available to the Ministry of Education are concentrated to meet prescribed demands, the effect can be phenomenal.

This study has also revealed that in our conventional schools, support for science has been minimal. Figures 7 and 8 provide useful data on both school expenditure items in schools and the mode of budgeting for science in schools. While teachers salary consume 77.05% of expenditure items in schools, laboratory equipment consumes only 1.97%. And when we study Figure 8, one observes that in the nine states sampled, schools that show 'none' in budget for science predominate. Even with the small budget for science claimed, it is the Principal, not the Head of Science who operates the budget - figure 9. The implication is obvious - with the principal operating the small science budget, the Head of science must be prepared to lose some or be told that due to other urgent school demand, there is only still very little available to science. In a science school, the Principal is a science graduate and so it becomes easier to see the need to put enough into science. The issues is different if the principal, as in many conventional schools is a non-science graduate.

The introduction of Remedial Science Programme in some Universities

The Federal Government through the national Universities Commission (NUC) gives special incentives to the Federal Universities for meeting the 60:40 admission quota. Some

universities with low applications for admission into their science programmes therefore embarked on a special remedial programme for those who plan to seek admission into their science programme. Those admitted into the science remedial programme come largely from the designated **University catchment area** for purposes of university admission. Over a period of one academic year, those selected for the programme are given intensive 'coaching' in the sciences. The students work in the university environment in reasonably well-equiped laboratories and taught by lecturers well qualified to teach science. Because the students admitted into the remedial science programme had already had a science background (attained grades of pass, not credit in their O-level), they do follow the lectures which are given at a fast pace. At the end of the academic year, the **university sets its own examination and using its laid down criteria, the students are formally admitted into the university to read for a degree in science.** By adopting this strategy, the university had sort of compensated for the deficiency of the students and at the same time been able to meet its admission quota for science.

Outcome

Remedial science programmes in those universities that offer them became very popular with the academically less-able students who otherwise would have not had the opportunity to follow a university programme in science. Universities were also able to meet their admission quota of 60:40 Science/Arts as laid down by Government.

Winning More Students for Science in Lagos State University (LASU)

This programme is unique in many respects. It is a departure from the second one described under "Remedial programme" and it is basically an experiment which has proved successful in one of the relatively newer university in Nigeria (LASU). The programme itself uses research approaches in solving an existing and important problem of shortage of science students seeking admission into universities. And furthermore, this is perhaps the only direct experiment in which an attempt is made to address the problem of not just shortage science students, **but science teachers**. This is a success story of how, through a university programme with very strong support from the Vice-Chancellor of the University, many more science teachers have been produced.

In a published account of the programme, the Vice-Chancellor with a team of other contributors (Olumide et al, 1987) provided the following information:

- description of the strategies employed in the experiment to 'woo' more students into first year science;
- the remedial training given to students on the pre-degree science programme;
- influence of the programme on the first-year admission into science-based courses;

- performance of the students in their first year science course.

In this experiment two programmes A and B are offered. **Programme A** was designed for those candidates who, probably through no fault of theirs, did not have the necessary credit level passes in science subjects to make them eligible for admission to science-based courses. These candidates were admitted to the Pre-Degree Science Programme with three instead of five O-level credits and with passes in two science subjects instead of credits.

Programme B on the other hand was for those who have the minimum requirements for University admission into courses in the **Humanities** but who preferred to switch to science-based courses. All a candidate needed therefore, were five O-level credit in arts subjects and the **will to study science.**

A major attraction for students to the Pre-Degree Science programme in Lagos State University is that tuition is free.

After the admission and registration processes, the programme plan for remediation is activated. The programme involves a system of diagnosis followed by a series of treatment. At the point of entry into the programme, each student is diagnosed for learning difficulty in Physics, chemistry, Biology, Mathematics and English. After this, the students go through a carefully prepared instructional

programme to remedy their weaknesses in these subjects. Students' interest are rekindled and sustained through a number of motivational strategies. Post-treatment evaluation is then carried out to assess the level of success of the treatment as well as for placement into different science-based undergraduate programmes.

Information obtained from the first stage of diagnosis forms the basis for treatment or remediation. Programmes A and B students are instructed in separate classes and in small groups. **Teachers are drawn from all the faculties in the University and the well-stocked laboratories of the Faculty of Science are used for practical classes.** With a total of 48 highly motivated teachers, audio-visual support from the Educational Technology Centre and ample opportunities for laboratory activities, the stage becomes more than set for a learning situation to prevail.

Each student group has, every week, 3 hours of lecture/discussion, 3 hours of practicals and 1 hour tutorials for each of Physics, Chemistry and Biology. For Mathematics, a group has 6 hours of contact for lecture/discussion and an hour for tutorials. 3 hours are allocated to English language.

The programmes adopt result-oriented techniques in the process of instruction. The relevance of the concepts being taught in class to the environment and the life of the student is brought out quite clearly in the lectures. A

multi-way interaction between the teacher, students and materials ensures that learning difficulties are continually diagnosed. Through a process of corrective feedback, students are then able to attain mastery of the subject matter.

At the end of the course, the students take comprehensive end-of-course examinations. To be eligible for admission to the 100-level, (first year university) a student must obtain at least the 40% pass mark in all the five subjects. Failure in one subject leads to a repeat of the course if an overall mean of 40% is not obtained or an outright withdrawal if the mean is lower than this threshold value.

In admitting students into the various science-based programmes at the 100-level, cognisance is taken of the choice of the students as well as the performance in the end-of-course examinations. **As much as possible, students are encouraged to elect science education courses.** This is with a view to providing many more qualified science teachers, for the school system so that the issue of "winning more students for science" can be tackled at the roots.

Outcome

The LASU experiment which started in a small way has now attained national recognition and replication of the experiment is taking place even in the older universities.

Summarising their work, the Vice-Chancellor and his team said: "Because several universities in Nigeria have found our experiment successful and adopted the procedure, we feel proud to recommend it to other universities in other parts of the world with a similar desire of winning more students for first-year science".

In-Service programme for Science and Mathematics Teachers

The rest of this study discusses programmes which are provided and managed by the various Ministries of Education and by Professional Science and Mathematics Associations. Each State of the Federation have a Ministry responsible for education and there is also a Federal Ministry of Education. There are two relevant professional Associations - **Science Teachers Association of Nigeria (STAN) and the Mathematical Association of Nigeria (MAN).** Both professional associations, STAN and MAN are very active in organising vacation for teachers.

At the primary Level

The initial goal of science education in Nigeria is for all primary school teachers to have the competence of teaching most of the subjects offered at that level (including science and mathematics). Ultimately, specialist teachers in some specialised areas (including science and mathematics) will be trained and available in sufficient numbers to all primary schools. Until the ultimate goal is

achieved, in-service programmes organised for teachers aim at addressing the shortage of competent primary school teachers to teach science and mathematics. Such in-service programme largely take place at Local Government and State Level. A Report submitted by one of the States in this study claim the following after a primary school in-service programme:

> **Our primary school science teachers learnt:**
>
> **(a) how to organise science laboratories;**
>
> **(b) maintain botanical and zoological gardens;**
>
> **(c) organize and carry out classroom activities;**
>
> **(d) manage large science classrooms;**
>
> **(e) use locally available materials in the teaching of science.**
>
> **Plateau State, 1992.**

The STAN conducts workshops for primary school science teachers annually through its Primary Science Panel. Over the period, 1982-1992, STAN has conducted eleven in-service workshops involving an average of 136 primary school teachers in each workshop.

At the Federal level, there is a Science and Mathematics primary school project which involves primary school teachers from selected 'Pilot Schools' all over the country. In-service programmes are conducted periodically for the teachers.

At the JSS Level

The science prescribed at the JSS level is 'integrated Science' which has created a lot of problems for those teaching it. As a result, the focus of the in-service programmes includes:

- up-dating the content learnt by the teachers;
- involving the teachers in improvisation of relevant equipment for teaching integrated science;
- training the teachers on how to teach large classes;
- use of the Integrated science books.

The STAN, considered the architect of Integrated Science in Nigeria runs a series of in-service workshops at both the State Branch and National levels. The workshops usually attract on the average about 200 teachers in each of the 30 States.

The Federal Ministry of Education in collaboration with the Science Teachers Association of Nigeria and the various State Ministries of Education run annually **Teachers Vacation Courses** (TVC). These courses not only help to up-date the science teachers in-service content but they also help to draw attention to recent Government policies and the requirements of the national examinations.

In-service programmes when properly organised constitute a significant input in tackling the problem of shortage of competent science and mathematics teachers.

Incentives for promoting Science and Mathematics among Students and Teachers

It is one thing to set up programmes for enhancing more students to science and mathematics but it is another thing to attract and retain such graduates in the teaching profession against the fierce competition with scientific industries. Again government came up with several packages for science and mathematics teachers:

(a) Post-secondary scholarships, to would-be science/mathematics student.

(b) Preferential admission policy for science and mathematics students - 60:40 ratio of science to arts subjects.

(c) Special Science Teachers allowance paid to science and mathematics teachers.

(d) Generous support to practising teachers for membership of Science Teachers Association of Nigeria (STAN).

(e) Special additional allowance and promotion prospects for science and mathematics teachers in rural areas of the country.

Conclusion

This country study has tackled a problem which is world-wide. Very few countries if any, have successfully put in place strategies in their educational system which over-produces science and mathematics teachers. Attempts have been made to train and retrain teachers to cope with the science and mathematics requirements in the national core curriculum. At the primary school level where science is introduced to enable children to:

learn from the environment;
and
learn for the environment

teachers are prepared continually to cope with every day issues that are relevant in a changing scientific and technological world. There will therefore be the need for primary school teachers to receive current training. Special attempt should be made to reach the large pool of available primary school teachers so that adequate numbers will show willingness and competence in coping with the subjects and shortage if present, will be much reduced. **The Nigerian educational system has therefore emphasised the key role of primary school teachers of science and mathematics.**

At the junior secondary level, the move from a generalist approach to specialised teaching for science and mathematics has been accepted. While the teachers are encouraged to specialise, the pupils are still presented with a very broad view of science in an integrated way. For some of the children, that may be the end of their broad study of science. With the combined effort of the **Science Teachers Association of Nigeria (STAN)** and the **British Council** through a grant from the Overseas Development Agency (ODA), a forward looking programme for teacher education has been put in place in Colleges of Education in Nigeria. Through short term in-service programmes, a crop of teachers is being trained to cope with the challenges of Integrated Science.

The issue of shortage of science and mathematics teacners should not be allowed to leave the agenda table of the educational system. Both at local and international levels, a co-ordinated effort must be supported to **train and re-train, up-grade and up-date** teachers who teach these supposedly key subjects - science and mathematics to the extent that the desired drift towards training as science and mathematics teachers will become a reality.

Here at the Education Programme of the Commonwealth Secretariat, attempts have been made to indirectly address the shortage of science, mathematics and technology teachers. Our route has been one of improving the quality of Science, Technology and Mathematics Education (STME) at the basic level. We have in one of our project focussed on the role of higher education institutions. A brief description of our project input in Nigeria is given:

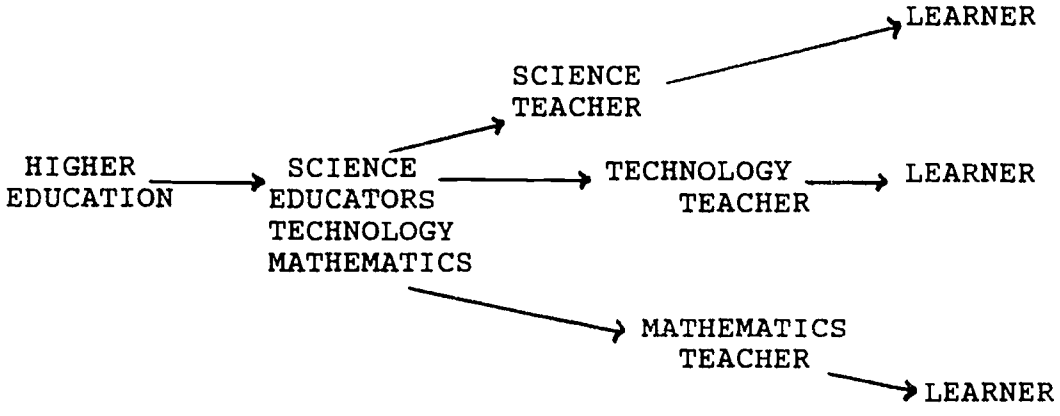
The Regional workshop in Science, Technology and Mathematics Education (STME)

Introduction

In May 1992, the Education Programme of the Commonwealth Secretariat brought together a team of resource people to deliberate on and then plan strategies which can be applied in Commonwealth countries in the improvement of the quality of Science and Mathematics Education at the basic level. Naturally the ultimate target of such a programme is the learner i.e. children in schools. The group was also conscious of the fact that the classroom teacher as well as those who train the classroom teachers have a major role to

play in any programme which seeks to improve the quality of science and mathematics education at the basic level, hence the role of higher education institutions.

Based on the above scenario, the schematic diagram below shows the links in the entire process of improving the quality of science, technology and mathematics at the basic level:



Improving the quality of STM education - the links.

Focus on the Science Educators

STM teachers are normally trained in Faculties of Education in the conventional universities or in Colleges of Education. The tutors in these institutions do normally obtain an advanced degree/diploma (Masters, Doctorates, Diploma) in higher education institutions after which they are recruited as tutors into Colleges of Education where they train teachers. With the modernity of the STM curriculum in schools (at the basic level), classroom teachers have to be adequately prepared to cope with their everyday tasks. Those therefore who train STM teachers must

themselves be adequately trained to enable them prepare effective teachers for the schools. It is that group of STM tutors, the Trainer-of-Trainers, that this workshop is aimed at.

Seven key issues were listed for discussion in the Nigerian workshop:

Issue 1: Who needs to be trained and why?

Issue 2: Where should the training take place?

Issue 3: How many people need to be trained?

Issue 4: How long should the training be?

Issue 5: What should be taught, and how?

Issue 6: Who should do the training?

Issue 7: Who pays for the training?

Outcome

The immediate outcome of the Regional Workshop in Nigeria is the production of draft monographs which could eventually be critiqued and distributed to interested teacher training institutions. The proposed monographs are listed.

Monograph No. 1
Training Needs of STM Tutors - Policy and practice

Monograph No. 2
Material Resources for STME training

Monograph No. 3
Co-ordinating STM in Schools

Monograph No. 4
Innovations in Teaching Practice for STM

Monograph No. 5
Measurement Assessment and Evaluation in STM

Monograph No. 6
STME Research

Monograph No. 7
PROJECT 2000+: Scientific and Technological Literacy

With such an input, the Education Programme of the Commonwealth Secretariat is helping to improve the quality of science, technology and mathematics not only in Nigeria but also in other parts of Africa. A follow up workshop in Zimbabwe has been envisaged.

Project on enhancing, the participation of girls and women into STME

The statistics available for primary education in many African countries show that women out-number men in the teaching force. The shortage of science and mathematics teachers at the primary level can be minimised if more girls and women are encouraged to offer these subjects while training as teachers. The Education Programme of the Commonwealth Secretariat over the years has also been involved in enhancing the participation of girls and women in science, technology and mathematics education, through the "Science Clinic for Girls and Women" and the "Roadshow".

Both programmes have a common framework of choosing as base, science and mathematics education making girls and women realise, that science, mathematics and technology are not male subjects but indeed that they too can actively participate in them. The Roadshow project along with the Science Clinic for Girls provide successful strategies of winning more girls and women for science and mathematics, thus reducing the shortage of science and mathematics teachers. The video-tape titled "Righting the Imbalance" is available at the Education programme of the Commonwealth Secretariat, London.

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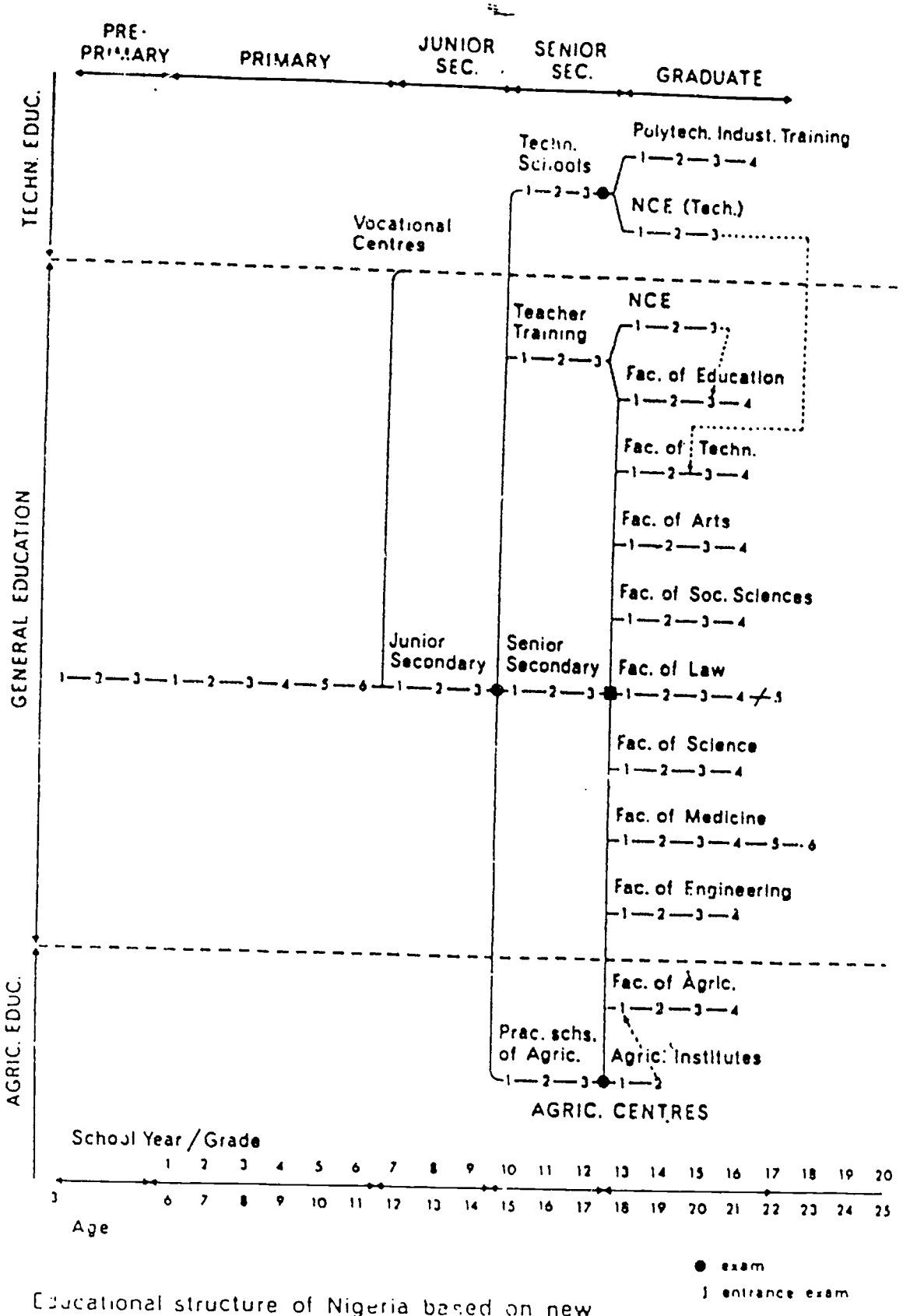
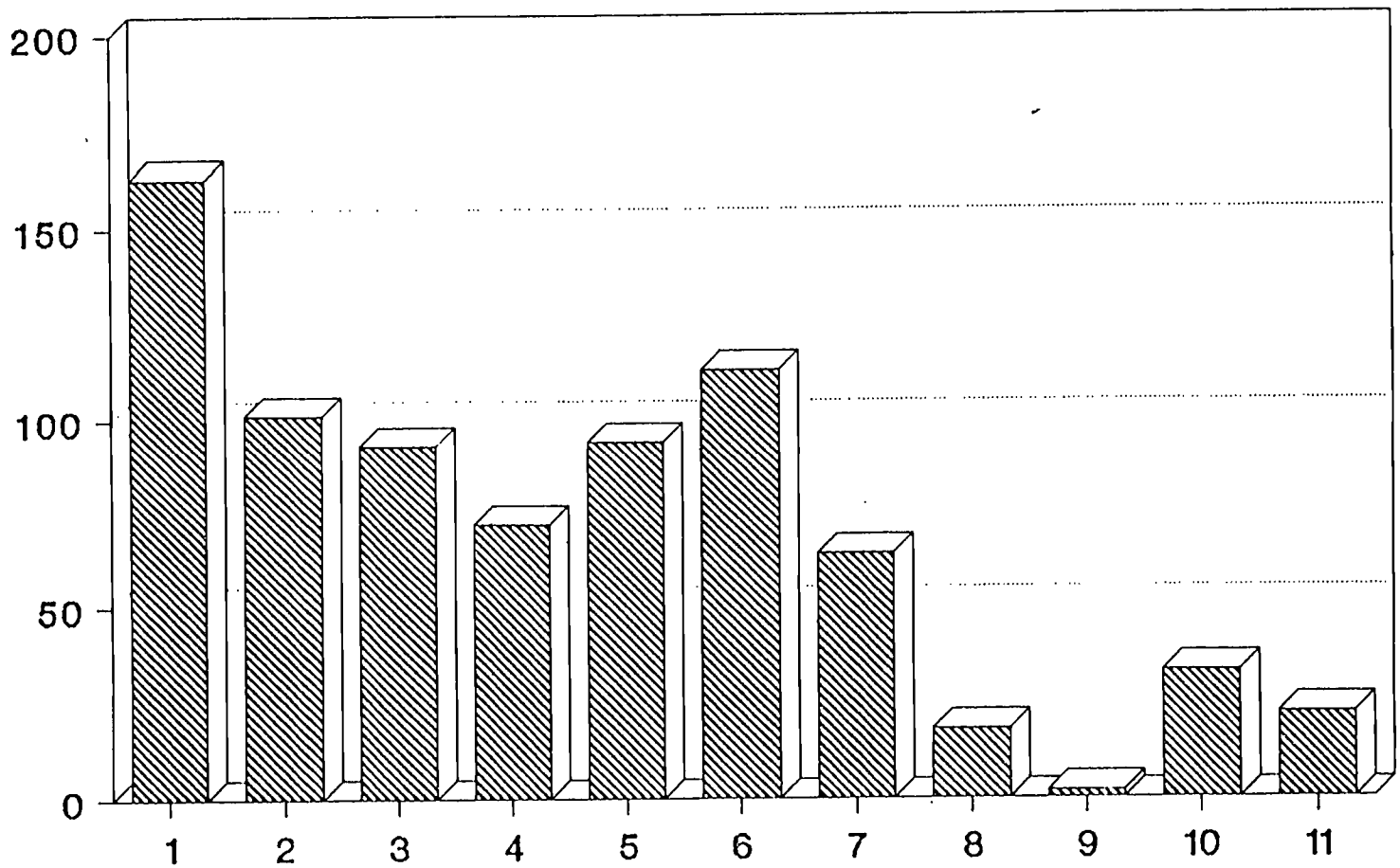
Appendix



Educational structure of Nigeria based on new National Policy on Education (1977)

Figure 1

SHORTFALL OF TEACHER REQUIREMENT IN A STATE



Legend

1 = Mathematics	5 = Agric. Science	8 = Metal Work	11 = Wood work
2 = Physics	6 = Intro. Tech.	9 = Electronics	
3 = Chemistry	7 = Integrated Science	10 = Tech. Drawing	

Figure 2

ADMISSIONS INTO A STATE UNIVERSITY

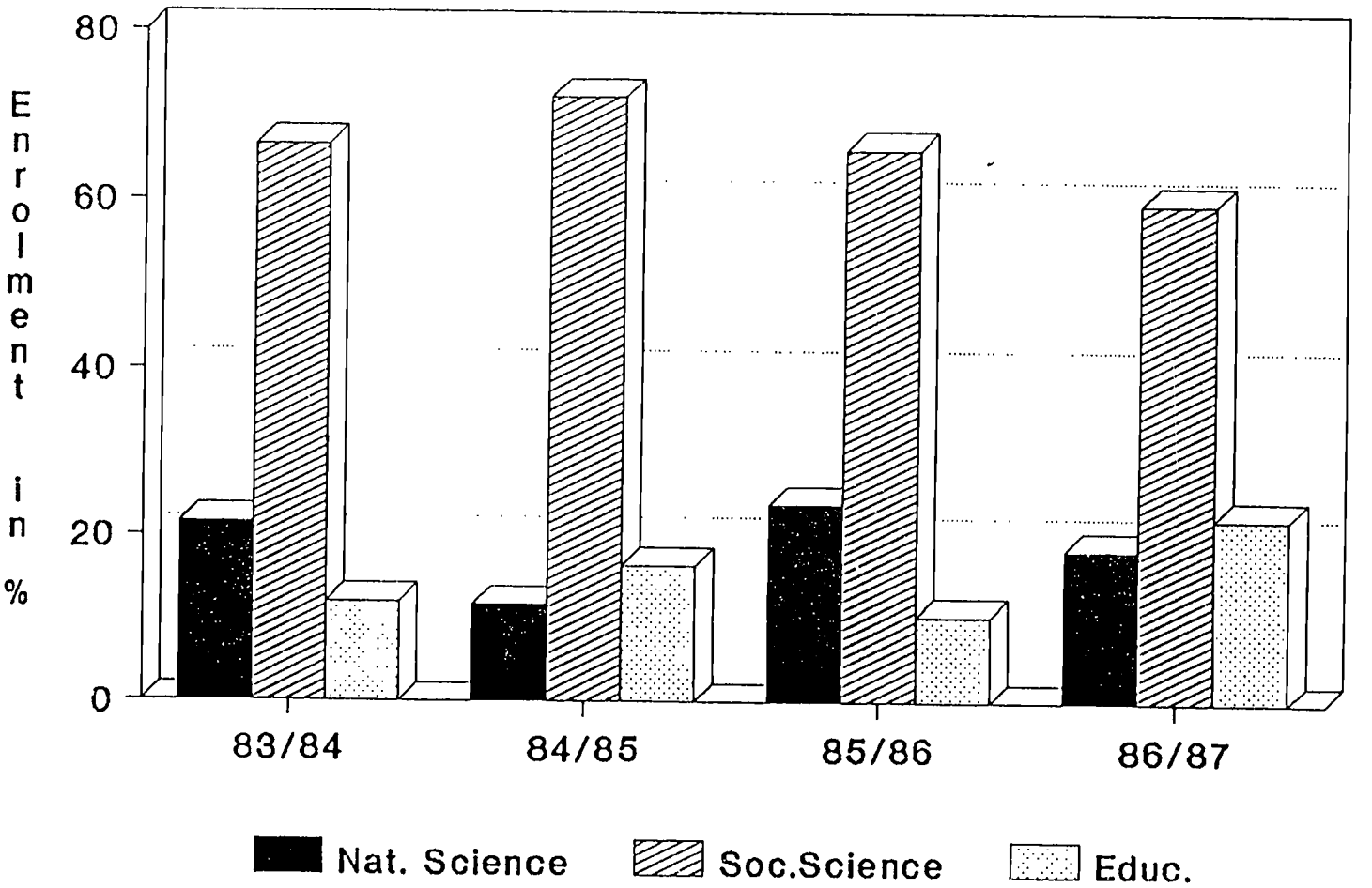


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Figure 3

ADMISSIONS INTO A FEDERAL UNIVERSITY

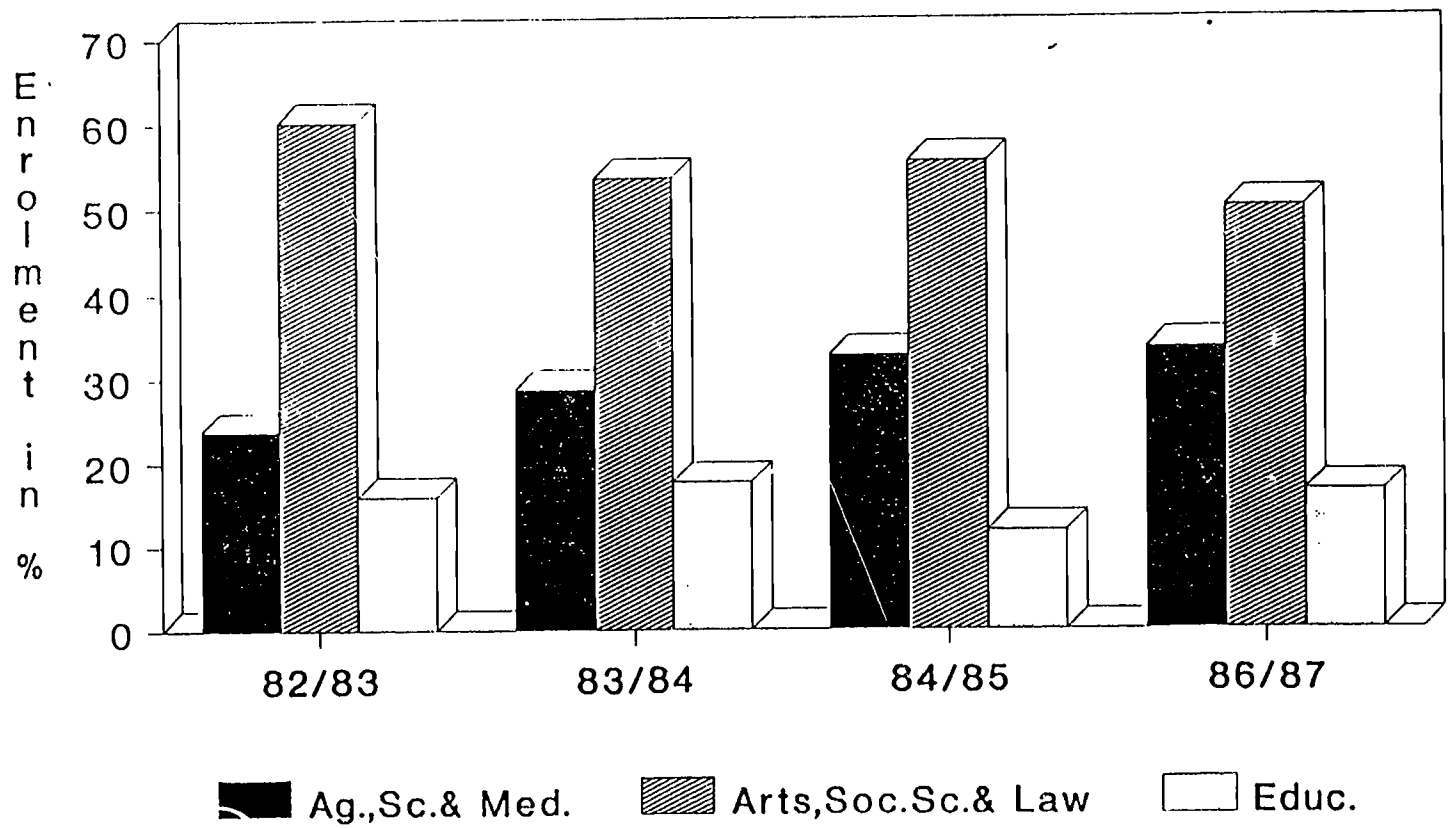

Figure 4

STUDENTS' PREFERENCES FOR SOME SELECTED SCHOOL SUBJECTS

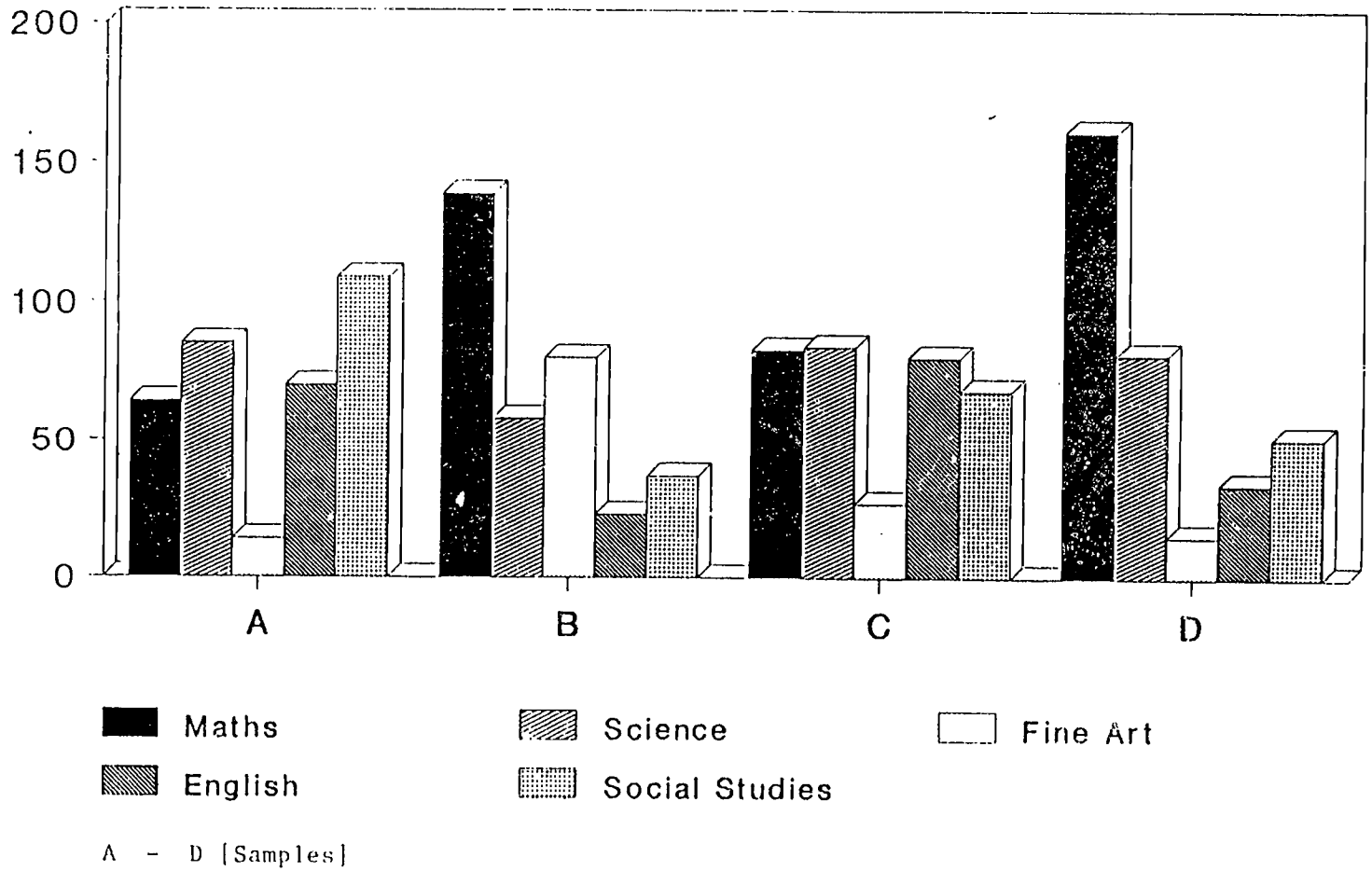

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Figure 5

REASONS FOR NON-OFFER OF SCIENCE

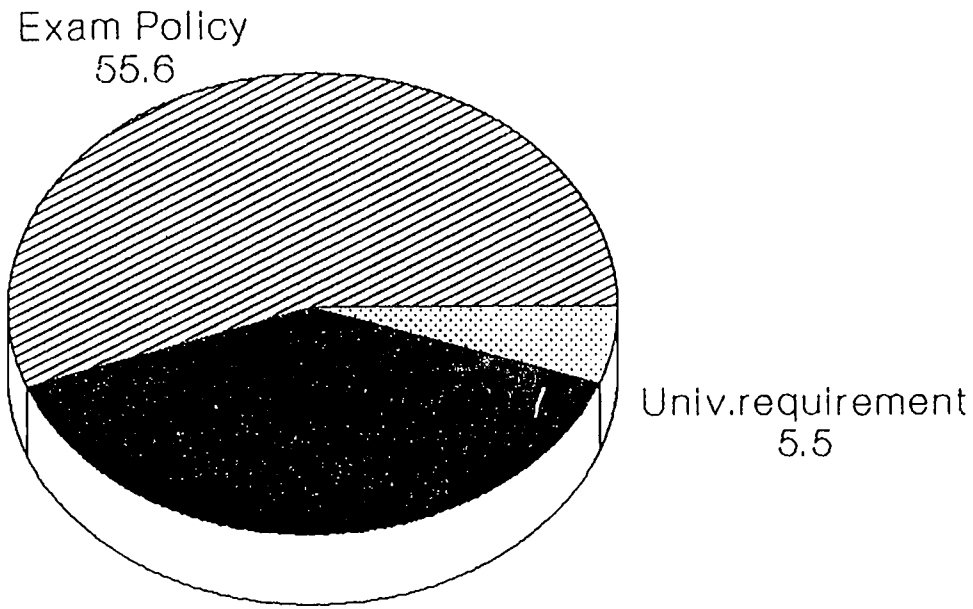


Figure 6

EXPENDITURE ITEMS IN SCHOOLS

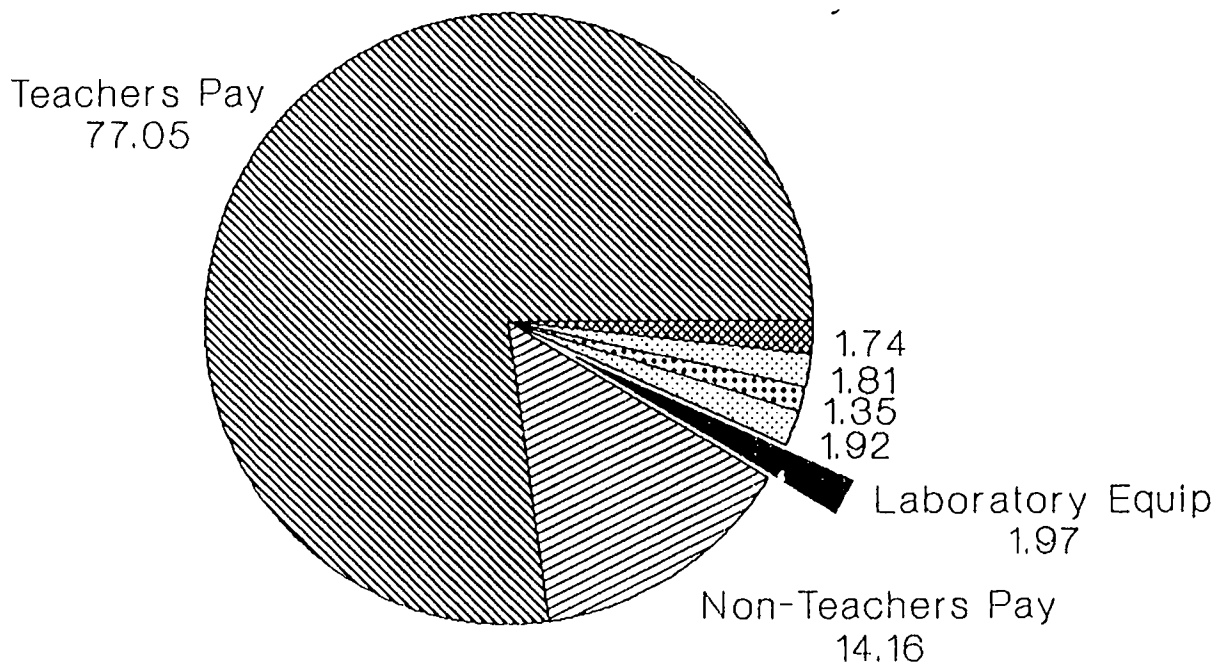
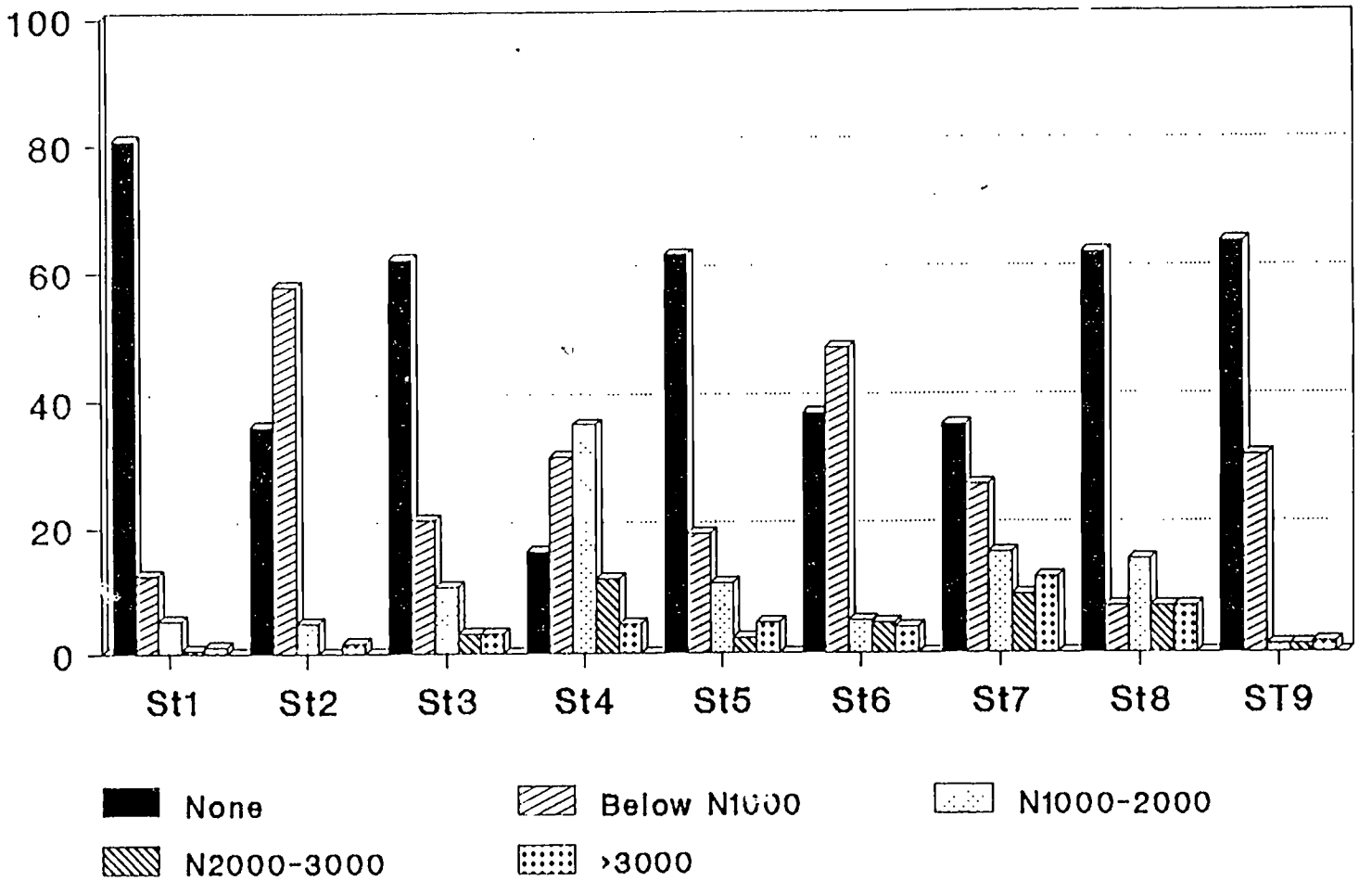


Figure 7

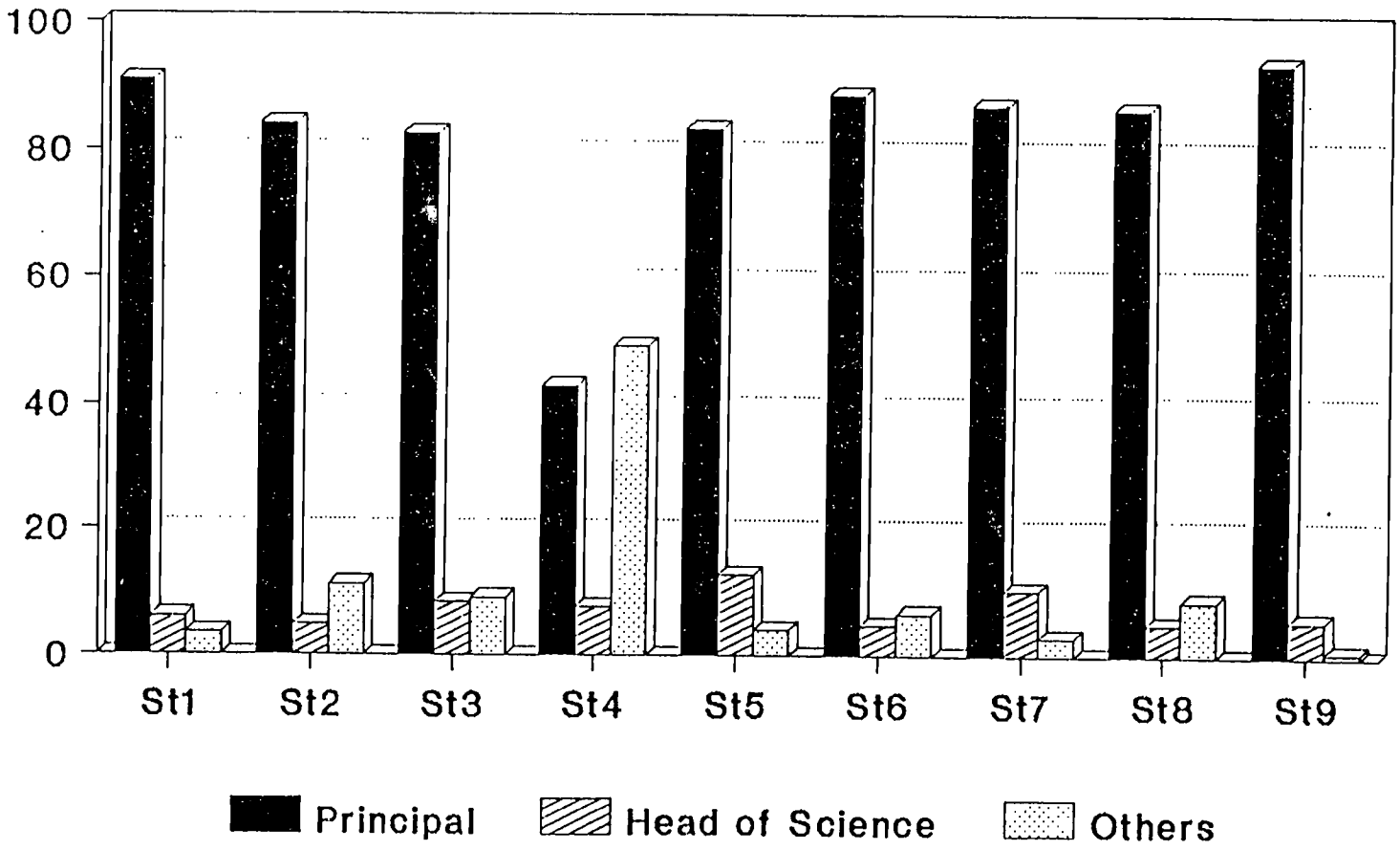
BUDGETTING FOR SCIENCE IN SCHOOL



St1 - St9 [Nine States in Nigeria]

Figure 8

OPERATORS OF SCIENCE BUDGET IN SCHOOLS



St1 - St9 [Nine States in Nigeria]

Figure 9

Table 1

Statistics on Primary School Educaiton in Nigeria*

YEAR	PUPILS			TEACHERS			NATIONAL AVERAGE PUPIL/TEACHER RATIO
	BOYS	GIRLS	TOTAL	TOTAL	MALE	FEMALE	
1989	6,997 356	5,723 732	12,721 087	344,221	190,979	153,242	37.1
1990	6,774 997	6,832 321	13,607 318	330,462?	181,929	148,537	41.1
1991	7,741 897	6,034 957	13,776 854	353,600	202,753	150,847	39.1

* Source: Nigerian National Commission for UNESCO (1992)

Table 2

Statistics on Secondary School Education in Nigeria*

YEAR	STUDENTS			TEACHERS			NATIONAL AVERAGE PUPIL/TEACHER RATIO
	BOYS	GIRLS	TOTAL	TOTAL	MALE	FEMALE	
1989	1,581 648	1,142 142	2,723 791	136,677	92,976	43,701	20.1
1990	1,254 204	1,239 714	2,893 918	142,548	97,063	45,485	20.1
1992	1,821 307	1,301 970	2,123 277	141,491	96,559	44,936	22.1

* Source: Nigerian National Commission for UNESCO (1992)

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TABLE 3

Students' Performance in GCE O- Level Agricultural Science (1981 - 1991)

		% Of All Candidates that Obtained a Given Grade			
Year	Entry	Total 1-6	Total 7-8	9	% In Grades 1-6
1981	44773	12477	11986	20310	27.86
1982	61666	30388	17463	13815	49.27
1983	100232	26823	48940	27469	26.76
1984	76819	24189	22745	28585	31.88
1985	142633	21790	32970	67873	15.28
1986	188134	32031	69785	86318	17.03
1987	159328	27459	60898	70971	17.23
1988	190422	802407	53253	54762	43.28
1989	63690	12751	25790	25149	20.02
1990	150587	37879	59122	53586	25.15
1991	220221	48174	73342	98705	21.88

Source: WAEC

FIGURE 1

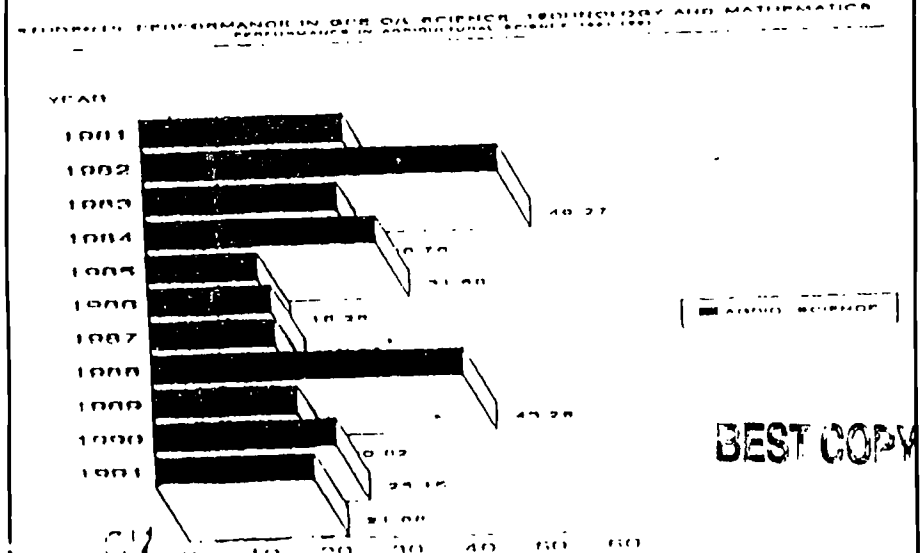

TABLE 4

Students' Performance in GCE O- Level Biology (1981 - 1991)

		% Of All Candidates that Obtained a Given Grade			
Year	Entry	Total 1-6	Total 7-8	9	% In Grades 1-6
1981	160941	21693	267044	112544	13.48
1982	237761	14454	26519	196808	60.08
1983	276990	24742	32917	219331	8.93
1984	299834	31707	60018	207308	10.60
1985	350476	41111	71221	237950	11.73
1986	392075	63389	86558	86558	16.17
1987	310503	34740	74642	201119	11.19
1988	345637	32520	81867	231300	9.41
1989	87710	10379	19552	57779	11.83
1990	190386	29942	58674	101770	15.73
1991	285690	72988	82270	130432	25.55

Source: WAEC

FIGURE 2

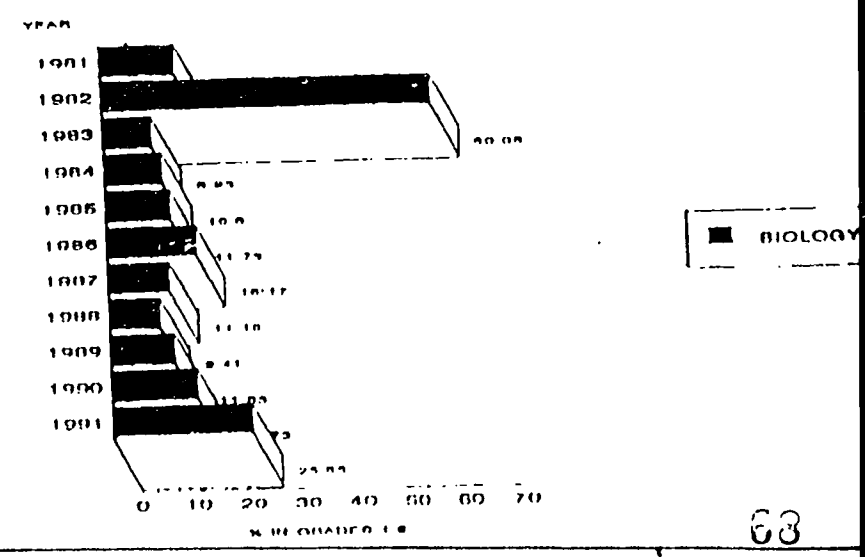

TABLE 5

Students' Performance in GCE O- Level Chemistry (1981 - 1991)

		% Of All Candidates that Obtained a Given Grade			
Year	Entry	Total 1-6	Total 7-8	9	% In Grades 1-6
1981	85992	18705	23434	43853	21.75
1982	10782	18848	31533	67445	17.48
1983	113473	13966	23408	76099	12.31
1984	112729	28779	76016	66834	25.53
1985	114380	22630	21857	69893	19.78
1986	134154	52523	70984	44622	39.15
1987	120765	32676	53952	46677	27.06
1988	142699	42182	48565	51952	29.56
1989	35702	3862	9522	22321	10.82
1990	80059	3307	16657	60095	4.13
1991	116526	12117	23585	80824	10.40

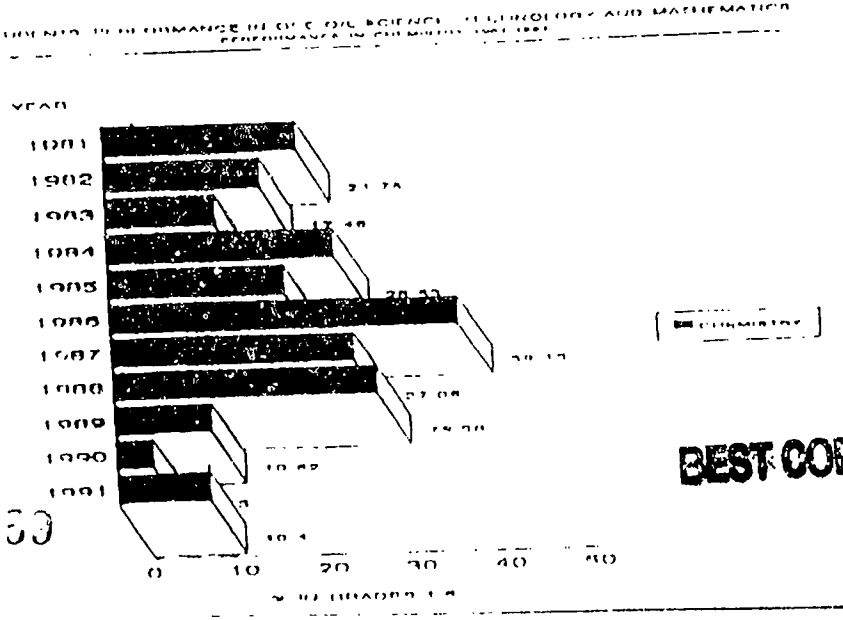

TABLE 6

Students' Performance in GCE O- Level Physics (1981 - 1991)

		% Of All Candidates that Obtained a Given Grade			
Year	Entry	Total 1-6	Total 7-8	9	% In Grades 1-6
1981	36469	8973	8499	18997	24.60
1982	49587	10106	12059	27422	20.38
1983	60531	8819	12343	39369	14.57
1984	62668	14690	14891	33087	23.44
1985	63062	16303	13880	32879	25.85
1986	79746	19790	19983	39973	24.82
1987	76656,	18922	28428	40564,.	24.68
1988	94963,	29577	22129	48257	31.15
1989	28524	2710	7688	18126	9.50
1990	63161	12741	20323	30097	20.17
1991	96742	17037	28601	51104	17.61

Source: WAEC

FIGURE 4

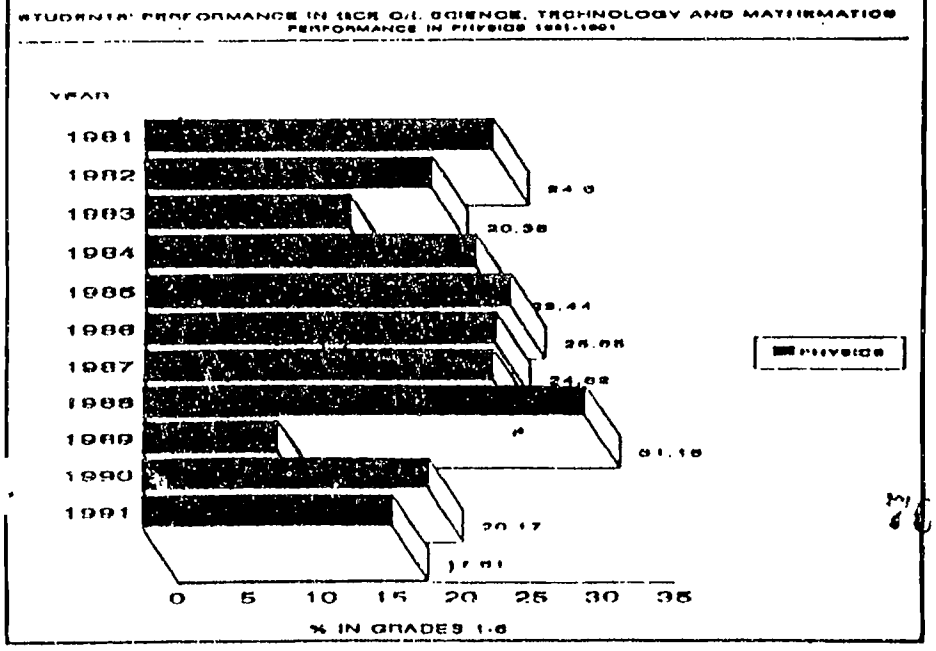

TABLE 7

Students' Performance in GCE O- Level Mathematics (1981 - 1991)

		% Of All Candidates that Obtained a Given Grade			
Year	Entry	Total 1-6	Total 7-8	9	% in Grades 1-6
1981	215315	13478	51556	150281	6.26
1982	286920	127575	89495	159345	44.46
1983	341758	30399	95508	125851	8.89
1984	388346	40710	100374	247262	10.48
1985	454264	52011	117487	284766	11.45
1986	523852	53414	129999	340439	10.20
1987	411258	57860	112517	240881	14.07
1988	473316	102670	132909	237737	21.69
1989	91142	7985	27312	55815	8.76
1990	195133	20614	72830	101689	10.56
1991	294079	32727	155240	146112	11.13

Source: WAEC

FIGURE 5

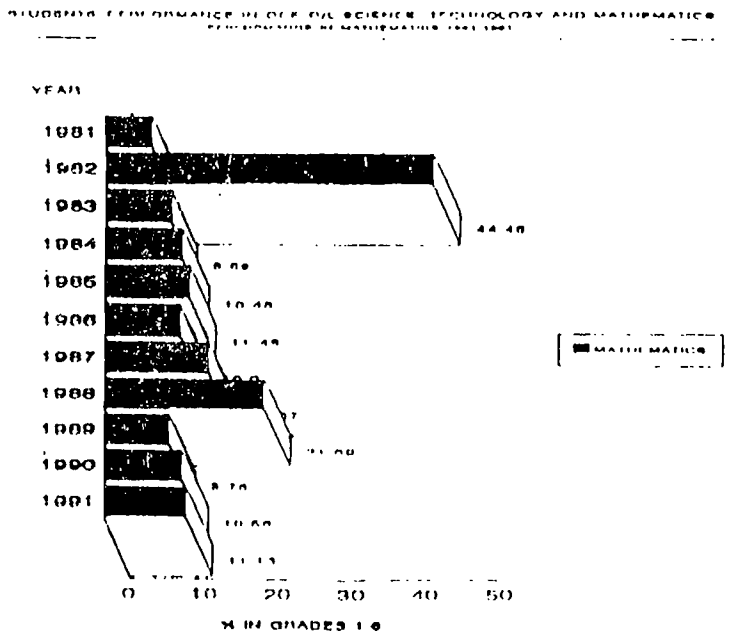

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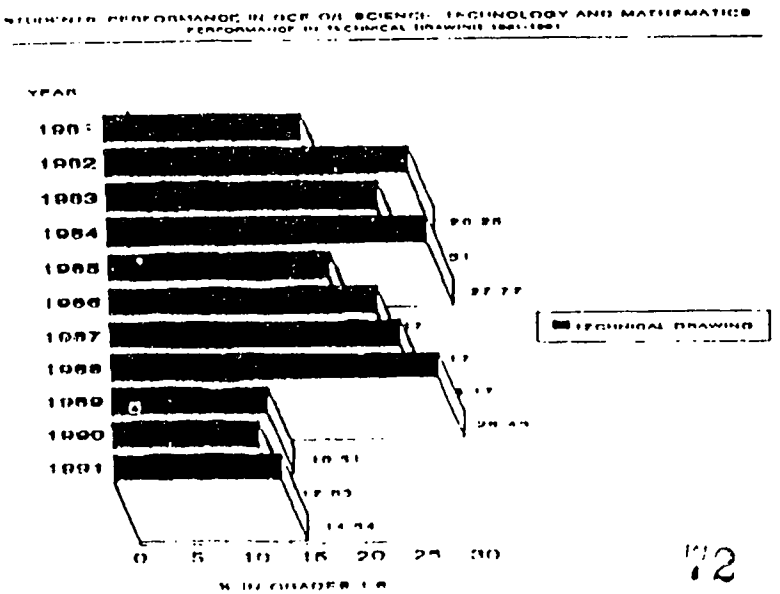
TABLE 8

Students' Performance in GCE O- Level Technical Drawing (1981 - 1991)

		% Of All Candidates that Obtained a Given Grade			
Year	Entry	Total 1-6	Total 7-8	9	% in Grades 1-6
1981	3590	613	2359	1538	17.08
1982	4899	1286	2646	1967	26.25
1983	6275	1475	1829	2971	23.51
1984	7335	2037	2356	2942	27.77
1985	7407	1450	2234	3723	19.17
1986	7815	1811	3133	2871	23.17
1987	5991	1508	1863	2620	25.17
1988	5075	1443	1387	2245	28.43
1989	5256	710	950	3596	13.51
1990	7204	910	1301	4993	12.63
1991	8748	1272	1869	5607	14.54

Source: WAEC

FIGURE 6



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