DOCUMENT RESUME

ED 389 689 SP 036 333

TITLE	Training of Trainers in Science, Technology and Mathematics Education: Regional Workshop Report (Kaduna, Nigeria, May 30-June 11, 1993). Improving the Quality of Basic Education in Science, Technology and Mathematics.
INSTITUTION	Commonwealth Secretariat, London (England).
SPONS AGENCY	Rockefeller Foundation, New York, N.Y.
PUB DATE	93
NOTE	89p.; For related reports on Quality in Basic Education, see SP 036 329-334. The workshop was hosted by the Nigerian National Commission for Colleges of Education.
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) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Case Studies; *Curriculum Development; Developing Nations; Educational Improvement; Elementary Secondary Education; Foreign Countries; Higher Education; *Inservice Teacher Education; *Mathematics Teachers; *Preservice Teacher Education; *Science Teachers; *Teacher Educator Education; Teacher Evaluation; Teacher Recruitment; Workshops
IDENTIFIERS	Africa; *Interactive Teaching; Malawi; Nigeria; Zanzibar

ABSTRACT

This publication reports on an African regional workshop in Nigeria on training science, technology, and mathematics teachers (STME). The workshop focused specifically on trends in recruitment and evaluation of academic and professional STME teaching staff in colleges of education and on initial training and inservice training for STME teaching staff in colleges of education. After a background summary and introduction to the workshop, the report includes outlines of texts of nine papers: (1) "Trainers of Trainers in STM: Framework for Discussion" (S. T. Bajah); (2) "Training Needs for STM Tutors" (Bryan Wilson); (3) "Do We Practice What We Preach? or Should We Change Our Practice or Our Sermon?" (Mike Savage); (4) "Interactive Teaching in Primary Science" (R. A. Hodzi); (5) "Science and Technology Education and Society: Bridging the Gap" (J. A. Anamuah-Mensah); (6) "Video and Teacher Education: Primary School Science Video Teacher Education in Malawi" (Harold F. Gonthi); (7) "Participating in Science Education Research" (Gilbert O. M. Onwu); (8) "Science Camps for Children: A Model for Curriculum Renewal and Change" (Shaaban S. Mohammed); and (9) "Project 2000+: Declaration." Appendices include a workshop program, the chairman's opening address, a goodwill message, a list of participants, and workshop evaluation results. (Some papers contain references.) (ND)

Improving the Quality of
Basic Education in Science,
Technology and Mathematics

Training of Trainers in Science, Technology and Mathematics Education Regional Workshop Report

Commonwealth Secretariat
1993

IMPROVING THE QUALITY OF BASIC EDUCATION IN SCIENCE, TECHNOLOGY AND MATHEMATICS

TRAINING OF TRAINERS IN SCIENCE ,TECHNOLOGY AND MATHEMATICS EDUCATION: REGIONAL WORKSHOP REPORT

Kaduna, Nigeria 30 May - 11 June 1993

COMSEC

NCCE

With Support from the
ROCKEFELLER FOUNDATION, NAIROBI
(African Forum for Children's Literacy in Science and Technology)

CONTENTS

SUMMARY

1. The regional workshop was held in Kaduna, Nigeria from 30 May to 11 June 1993. Three organisations sponsored the workshop with varying inputs. The Commonwealth Secretariat provided seed money for the workshop and the Rockefeller Foundation sponsored the non-Nigerian consultants. The Nigerian National Commission for Colleges of Education (NCCE) hosted the workshop.

2. The NCCE was selected as host for the workshop because of its parastatal status. The Commission was set up by the Nigerian Government to administer all colleges of education in the country. The Commission also provides to the colleges guidance and support in academic and professional growth.

3. The workshop agenda was organised around seven key questions that relate to education of staff for colleges of education:

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 should pay for the training?

4. Right from the beginning of the workshop, it was made clear that paper presentation would be reduced to a minimum - this was a <u>workshop</u>, instead of a talkshop. Consultants, therefore, presented their papers during the first two days and these were later used as background material for group discussions.

5. A special feature of the workshop was a classroom interaction with teachers in a college of education. The consultants, led by Mr Mike Savage, held very useful discussions on how to use the Candle Experiment to generate questions. Principles which involved scientific, technological and mathematical skills were discussed. Novel activities with the burning candle were derived. Mr Savage continually stressed the need to use the activity method in teaching science.

6. Participants were divided into three groups for the workshop sessions. Each group developed two monographs. The monographs, still in draft form, were discussed in plenary sessions and were modified by groups according to comments from plenary sessions. The six draft monographs have been bound separately and will be distributed as a separate volume.

7. Participants made a number of recommendations during the evaluation session that was held at the end of the workshop. They included:

(i) Regular INSET programmes should be organised for both academic and non-academic staff of colleges of education.

(ii) There should be a national/regional forum for academic staff of the colleges of education to meet and discuss topical issues in the teaching of STM.

(iii) As the computer has become a versatile equipment in education, plans should be made to have special workshops on use of computers in colleges of education.

(iv) Participants strongly recommended follow-up workshops for all of them who attended the workshop, and stressed the importance of distance education.

(v) The importance of distance education as a contribution to INSET programmes was stressed.

(v) Participants recommended that the Commonwealth Secretariat should include their names on the Secretariat's regular mailing lists for receipt of future Comsec publications.

WORKSHOP CO-ORDINATORS

Professor P N Lassa
Executive Secretary (NCCE) **and** **Professor S T Bajah**
Chief Project Officer

INTRODUCTION

The initiatives which created the forum for this workshop were provided by the Education Programme (EDP) of the Commonwealth Secretariat. This followed the mandate given by the Eleventh Commonwealth Conference of Education Ministers in Barbados 1990 (11CCEM) and the Commonwealth Heads of Government Meeting in Harare in 1991, to pursue programmes that will improve the quality of basic education. Resulting from this, attention was focused on the role of Higher Education in Science, Technology and Mathematics Education in improving the quality of STME.

Based on the above information, a national/regional Training of Trainers workshop was jointly organised by the Commonwealth Secretariat in London and the National Commission for Colleges of Education, Kaduna, Nigeria, to review the strategies of training STM teachers for the primary and secondary school level of Education in Nigeria and other Commonwealth countries. The workshop was scheduled to last 12 working days.

I. SCOPE AND OBJECTIVES

The workshop specifically focussed on:

i. trends in the recruitment of STME staff lecturers in colleges of education;

ii. suitability of academic and professional staff in colleges of education;

iii. minimum level of academic and professional qualifications of lecturers;

iv. initial training needs of STME teaching staff in colleges of education; and

v. evolving suitable in-service programmes for STME teaching staff in Colleges of Education.

II. PARTICIPANTS

A total of 20 participants from colleges of education were selected to represent the disciplines of science, technology and mathematics. However, the workshop attracted well over 36 participants - 16 more participants outside the initial plans (see appendix IV).

Six resource persons were drawn from Ghana, Malawi, Zimbabwe, Kenya, Tanzania and Nigeria.

III. OPENING CEREMONY

The workshop was declared open by the Deputy Governor of Kaduna State, Mr James Bawa Magaji, who was accompanied by the Honourable Commissioner for Education. In his brief address, he drew attention to the importance of science and technology in the development of any country. He particularly underscored the role which teachers could play in science, technology and mathematics education. Kaduna State, he said, was particularly grateful to the Commonwealth Secretariat for initiating and supporting the workshop. He concluded by pledging support for the planned activities during the entire workshop.

The chairman of the occasion, the Executive Secretary of the National Commission for Colleges of Education (NCCE), Professor P. N. Lassa read his address in which he reminded the audience of the role of the NCCE. This workshop, he said, is one of the activities which has received the support of the Commission. He welcomed the participants especially the consultants from outside Nigeria.

The goodwill message from the Director of the Education Department of the Commonwealth Secretariat, Mr Peter Williams was read by Professor S. T. Bajah, Chief Project Officer for Science, Technology and Mathematics Education (STME), Commonwealth Secretariat, London. The role of the Secretariat in improving the quality of basic education in member countries was highlighted.

IV. PLENARY SESSIONS

The first plenary session, Setting the Pace, was presented by Prof. S. T. Bajah and introduced the framework for the workshop. The highlight of his paper touched on the scope and objectives of the workshop, context, strategy adopted, expected outcome of the workshop and follow up. Prof. Bajah emphasised that the essence of the workshop is an attempt to improve the quality of STME where the pupils are actors. Prof Bajah explained clearly that the workshop was a writing one and not a conference.

At the end of the first day, participants were clear in their minds as to what their tasks and their expectations were going to be.

Activities of the second day was led by Mike Savage of the Rockefeller Foundation. He proposed that science teachers should endeavour to:

(i) teach science as an investigation;

(ii) conduct research, and

(iii) use resource materials from local environment.

The main events of the day were devoted to the presentation of papers by the six consultants and development of a framework for the monographs. During these presentations there were video shows to back up the areas of focus. The video films provided the basis and opportunity for discussions.

One of the exciting highlights of the workshop was the demonstration lesson at the Federal College of Education, Zaria. This activity was led and conducted by Mike Savage. The simple classical candle experiment generated a very interesting scientific discussion.

V. GROUP SESSIONS

For the remaining days of the workshop, efforts were concentrated on group work on development of the monographs. The workshop broke into three groups, based on the titles of the monographs. Each of the consultants served as facilitator to each group.

Group 1 - Monographs 1 and 6
Group 2 - Monographs 2 and 4
Group 3 - Monographs 3 and 5

The five objectives (identified above) for the workshop were carefully developed into the main focus areas. These focus areas provided the basis on which the monographs were produced. The six draft monographs and some of the highlights are as follows:

MONOGRAPH ONE - Training Needs of STM Tutors

- general overview/purpose
- recruitment of STME tutors
- selection procedure for STME tutors
- promotion prospects
- academic and professional needs
- professional responsibilities
- INSET programme
- recommendations

MONOGRAPH TWO - Mobilising Material Resources for STME Training

- identification/acquisition of manufactured items
- identification/acquisition of locally available items
- improvisation of items
- making of transparencies as teachers' aids
- proper use of OHP
- making/using video tapes for teacher education
- recommendations

MONOGRAPH THREE - Co-ordinating Science, Technology and Mathematics in Schools

- orientation workshop/implementation of objectives
- managing school resources
- organising in-school workshop and activities
- organising out-of-school STM activities
- teaching STM to large classes
- summary

MONOGRAPH FOUR - Teaching Practice for STM

- organising/co-ordinating teaching practice
- duration of teaching practice
- supervision of teaching practice
- specialist supervision
- generalist supervision
- record keeping in teaching practice
- student-teacher placement record sheet
- assessment sheet
- attendance sheet
- micro-teaching
- summary

MONOGRAPH FIVE - Measurement, Assessment and Evaluation in STM

- need for accountability
- evaluation in STM programme
- make of accountability/monitoring system
- communicating quantitative/qualitative information
- formative/summative evaluation
- continuous assessment in STM
- evaluation in STM
- evaluation records

MONOGRAPH SIX - Participating in Research

- purpose/what is STME research?
- what research says to STME tutors
- STME tutor as a researcher
- initiating research
- writing research proposal
- writing research report
- strategies for encouraging action-research

The aims and objectives of the workshop were achieved. All the monographs were completed in draft form at the end of the workshop. The workshop was rounded up with a closing ceremony. The Honourable Commissioner for Education, Kaduna State declared the workshop closed.

VI. SUMMARY OF ACTIVITIES

Eight background papers were presented as follows:

1. **Trainers of Trainers in STME: Framework for Discussion** - Background paper by Professor S T Bajah, Chief Project Officer, Commonwealth Secretariat;

2. **Training Needs for STM Tutors** by Bryan Wilson - presented on his behalf by Prof S T Bajah;

3. **Do We Practice What We Preach or Should We Change?** by Mike Savage, Rockefeller Foundation;

4. **Interactive Teaching** by Dr R A Hodzi, Department of Science and Mathematics Education, University of Zimbabwe;

5. **Science and Technology Education and Society: Bridging the Gap** by Dr J Anamuah-Mensah, Department of Science Education, University of Cape Coast, Ghana

6. **Video and Teacher Education: Primary School Science Video Teacher Education in Malawi** by Harold F Gonthi, Malawi Institute of Education

7. **Participating in Science Education Research - Supporting Teacher Change** by Dr Gilbert O M Onwu, Department of Teacher Education, University of Ibadan, Nigeria

8. **Science Camps for Children: A Model for Curriculum Renewal and Change** by S S Mohammed, Educational Research and Curriculum Development, Penba - Zanzibar, Tanzania

TRAINING OF TRAINERS IN SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION (STME)

FRAMEWORK FOR DISCUSSION

Professor S. T. Bajah

I. INTRODUCTION

Following the Commonwealth Conference of Education Ministers (CCEM) in Barbados (October 1990) and the recent meeting of Commonwealth Heads of Government in Harare (October 1991), the Education Programme (EDP) of the Commonwealth Secretariat was given a mandate to pursue programmes that will improve the quality of basic education. With respect to Science, Technology and Mathematics Education (STME), attention was focussed on the role which higher education institutions can play in improving the quality of STME. The Trainer of Trainers (TOT), i.e., academic/professional staff in Colleges of Education responsible for the training of STM teachers became a target group. This programme therefore is meant to raise the quality of TOTs so that their products, the teachers who go into basic education to teach will deliver STM in a stimulating way relevant to the needs of the children in schools.

II. SCOPE AND OBJECTIVES

The National/Regional workshop should provide an opportunity for lecturers of STM in Colleges of Education to review their strategies for training STM teachers who are being prepared to teach in both the primary and secondary school cycle of education in Nigeria and other Commonwealth countries. Innovative practices in the training of STM teachers will be identified and reviewed.

Focussing specifically on STME, the workshop would:

(a) identify the trend in the recruitment of STME staff for Colleges of Education;

(b) assess the suitability of the academic and professional staff in Colleges of Education;

(c) specify the minimum level of academic and professional qualification most suitable for STME lecturers in Colleges of Education;

(d) make suggestions for initial training of the STME teaching staff In Colleges of Education;

(e) evolve suitable in-service programmes for STME teaching staff in Colleges of Education;

Seven key issues/questions were derived from the above aims, with special emphasis on STME teachers in Colleges of Education:

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?

III. CONTENT

The training workshop is scheduled to last 12 working days:

Days 1 - 3 (3 days)	Orientation and developing plan of action
Days 4 - 8 (5 days)	Group discussion and exchange of experiences; writing of draft training materials;
Days 9 - 10 (2 days)	Plenary discussion and critique sessions;
Days 11 - 12 (2 days)	Production of final versions of training materials.

The orientation will involve real classroom experience with STM teachers in an identified College of Education. Participants will be challenged and expected to participate in tackling the question -

"DO WE PRACTICE WHAT WE PREACH?"

A suggested list of monographs is attached.

IV. PARTICIPANTS

Three groups of participants have been selected for this workshop:

(a) A total of 20 local participants were judgmentally selected from Colleges of Education to represent the three disciplines of **science, technology and mathematics education**. The criteria for selection among others included ability to play leadership role in the training of other STM education lecturers in Colleges of Education. Out of this pool of 20 the group which will act as facilitators in similar regional workshops will be selected.

(b) A total of seven researchers were selected to present and discuss aspects of their work which is relevant to the training of STM tutors.

(c) A small core of consultants will be selected to act as group leaders in relevant aspects of training STM tutors.

V. STRATEGY ADOPTED

After every intensive discussion in-house here in the Education Programme, specific objectives were identified and a set of modalities proposed. A planning meeting of consultants was organised in May 1992 and a series of recommendations were made. One which is relevant to the above project relates to "a structure for continuing, school-focussed, and inter-related in-service education (INSET) for teachers and teacher educators involving the concept of key teachers and a Cascade Strategy". To that effect, a series of regional workshops followed by national workshops have been suggested. (This workshop in Nigeria is therefore the first in the series of national-regional workshops).

VI. VENUE

This workshop is being hosted by the National Commission for Colleges of Education (NCCE), Kaduna. NCCE has completed arrangements to use the facilities available at the National Teachers' Institute (NTI), Kaduna for the workshop.

Accommodation in Kaduna will be in Durbar Hotel.

VII. RESOURCE PERSONS (Consultants)

Resource persons have been identified and invited to the workshop. Three out of the five resource persons participated in the planning meeting in Hertford, the report of which is included in the folders. The resource persons, all experienced teacher trainers will in essence act as facilitators during the workshop.

VIII. OUTCOME

At the end of the training workshop, draft training monographs would be produced. The monographs will address the various issues raised and based on the advice of the consultants, the monographs will be combined into volumes. (See the attached list of suggested monographs).

IX. SPONSORS

This regional workshop is being sponsored by three organisations.

(a) The Commonwealth Secretariat, London (Comsec)

(b) The National Commission for Colleges of Education, Kaduna (NCCE)

(c) The Rockefeller Foundation, Nairobi (The African Forum for Children's Literacy in Science and Technology).

It is hoped that other interested international agencies who have been invited to this workshop as observers will fully participate in subsequent workshops.

X. FOLLOW-UP

The focus of this workshop will be kept alive. Using our cascade model, a series of national regional workshops will follow, organised and run by participants who have attended this workshop. Two regional workshops have earmarked to take place before April 1994:

(a) Regional Workshop in Zimbabwe to cater for East and Southern Africa.

(b) Regional Workshop in Suva to cater for the Pacific and Small Island States.

PROJECT 2000+ - Science and Technology Education for All

These series of workshops in STM for the Trainer of Trainers have a direct link with the Phase 3 of the UNESCO/ICASE/COMSEC initiative of "**Science and Technology Education for All**".

Details of Project 2000+ have been provided in the documents made available to participants at this workshop in Kaduna.

IMPROVING THE QUALITY OF SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION

SOME SUGGESTED FOCUS AREAS FOR PREPARATION OF MONOGRAPHS

Monograph One

TRAINING NEEDS OF STM TUTORS

- Survey of present trend in recruitment
- Academic and professional responsibilities
- Academic needs and qualifications
- Professional needs and qualifications
- INSET programmes for tutors

Monograph Two

MOBILISING MATERIAL RESOURCES FOR STME TRAINING

- Identification and acquisition of manufactured items
- Identification and acquisition of locally available items
- Making transparencies as teaching aids
- Proper use of OHP
- Making and using video tapes for teacher education

Monograph Three

CO-ORDINATING STM IN SCHOOLS

- Selection and training of head teachers for STM
- Managing school resources for STM
- Organising in-school workshops
- budgeting for STM in schools
- organising out-of-school STM activities
- teaching STM to large classes

Monograph Four

TEACHING PRACTICE FOR STM

- Organising and co-ordinating teaching practice
- Record keeping in teaching practice
- Micro-teaching

Monograph Five

MEASUREMENT ASSESSMENT AND EVALUATION IN STM

- Need for accountability
- Communicating quantitative information
- Continuous assessment
- Record keeping

Monograph Six

PARTICIPATING IN STME RESEARCH

- What does research say to the STM teacher
- Initiating research
- Writing research proposals and reports
- Bridging school science and technology

Monograph No. Seven

STME FOR ALL

- Project 2000+

Monographs eight- ten

- Any suggestions?

TRAINING NEEDS OF STM TUTORS

Bryan Wilson

PURPOSE

This paper is concerned with the proposed Monograph No. 1 at the Commonwealth Secretariat National-Regional Workshop, 1993. It attempts to provide a framework within which participants can develop a draft of the Monograph.

INTRODUCTION

The Commonwealth Secretariat Project has as its ultimate purpose the raising of the quality of STME at the Basic Education level in countries across the Commonwealth. The Project recognises that STM tutors in institutions of higher education, including Colleges of Education, are the group of people who hold the key to this.

Traditionally, however, such tutors are recruited largely on academic criteria and qualifications, with comparatively little attention being paid to their school teaching experience, classroom effectiveness, commitment to children or appreciation of broader curriculum issues in schools.

The situation is made worse by the lack of training programmes, either initial or in-service, specifically designed for STM Tutors. It seems to be assumed that, if they have done well in their own academic studies, they are thereby capable of training teachers to teach that subject effectively to children.

This project aims to develop a set of Monographs which will both point to the need for serious INSET training for STM Tutors, and provide resources for such training. No. 1 in the series, "Training Needs of STM Tutors", will survey the present situation in terms of the recruitment, qualifications and responsibilities of STM Tutors, and outline principles for the development of INSET programmes for them.

SECTIONS OF MONOGRAPH

The following main sections are suggested:

- Recruitment of STM Tutors
- Academic responsibilities of STM Tutors
- Academic qualifications and needs of STM Tutors
- Professional responsibilities of STM Tutors
- Professional qualifications and needs of STM Tutors
- Content of INSET programmes for STM Tutors

Participants should contribute views and information from their own countries/regions/institutions to help include answers to the following questions in the Monograph:

RECRUITMENT OF STM TUTORS

What weight is given to formal academic qualifications - Doctorate/Masters/Diploma/other - in the appointment of STM Tutors?

What weight is given to school teaching experience in the appointment of STM Tutors?

Is it possible for a person to be appointed as a STM Tutor who has never taught in a school at the level for which his/her students are being trained? If so, is this acceptable?

Is there evidence that present recruitment criteria for STM Tutors results in effective professional training for their students?

Who selects STM Tutors? How can they be influenced to adopt more appropriate criteria?

ACADEMIC RESPONSIBILITIES OF STM TUTORS

What academic levels are aimed at in training STM teachers for the Basic Education cycle?

What academic examinations are incorporated into their courses? Are these examinations explicitly designed for teachers in training?

Are these academic levels and examinations appropriate for trainee teachers for the Basic Education cycle?

If it is considered that the academic levels currently demanded are not appropriate, who has the power to change them, and how can they be influenced to do so?

ACADEMIC NEEDS AND QUALIFICATIONS OF STM TUTORS

Are the present academic qualifications required for appointment as a STM Tutor actually necessary for the fulfilment of his/her future academic responsibilities, or are they used simply to cut down the field of likely applicants?

Is there any provision for the academic updating of STM Tutors? Does there need to be?

PROFESSIONAL RESPONSIBILITIES OF STM TUTORS

Is the professional training of STM teachers left entirely to a 'Professional' Department? Or does every STM Tutor see his/her role in professional as well as in academic terms?

List the 'professional' responsibilities of STM Tutors.

Do all Tutors recognise all these professional responsibilities?

Is the academic/professional balance of responsibility satisfactory? If not, how can it be changed?

In teaching their subject, do STM Tutors deliberately adopt methodologies that will help their students to see how the subject-matter can be taught in school?

Or do they just 'lecture'?

How can Tutors be influenced to use methods of teaching themselves that reinforce their students' professional training, and model the methods that they will be encouraged to use in schools?

PROFESSIONAL NEEDS AND QUALIFICATIONS OF STM TUTORS

In the light of the information thrown up in the previous sections, participants should consider some major recommendations under this heading, which is the main thrust of this Monograph. For example:-

(a) Teacher education needs to be seen as a profession in its own right, separate from that of e.g. 'mathematician' or 'scientist' or 'researcher' or 'university lecturer' or 'academic'. See Mary Harris (1992), para. 31.

(b) There needs to be a major shift from the 'academic' to the 'professional' in the selection and training of STM Tutors.

(c) No STM Tutor should be appointed without successful school classroom experience, preferably for a minimum of five years.

(d) All newly-appointed STM Tutors should undergo a training programme to prepare them for their new responsibilities.

(e) INSET programmes should be available for all STM Tutors. It is for consideration whether regular participation in INSET should be a condition for continuing in post.

INSET PROGRAMMES FOR STM TUTORS

Do any INSET programmes, specifically designed for STM Tutors, exist? If so, list them. Are they primarily academic or professional?

What form do they take? Are they in-college? Day-courses? Week-end courses? Vacation courses? Self study courses? Correspondence courses? In-school courses?

What provision is there for STM Tutors who have been in post for some years to update their own teaching experience at the level for which they are training their students to teach?

This project proposes a 'Cascade Strategy' of INSET provision; see Mary Harris (1992), paras 20 - 22 and 32 - 37. The strategy would involve both STM Tutors and STM teachers in schools. This Monograph should summarise this strategy, and explain that other Monographs in the series will deal more with the content of such INSET courses.

The basic principles on which such INSET courses could be based include:-

- academic and professional INSET cannot be separated;

- tutors have varying needs at different career stages; see Mary Harris (1992), para 29;

- key teachers should be involved in INSET for Tutors;

- courses should not be narrowly subject-focussed, but should be constructed against a background of broad curriculum issues and inter-disciplinary approaches. An excellent exemplar of such an approach is Gibbs and Mutunga (1991), which develops the teaching of mathematics at Basic Level in a way which integrates it with health education. Two others in this series are due for publication by Longman in 1994: 'Health into Social Studies' (July 1994) and 'Health into Science' (September 1994);

- the professional associations for science, technology and mathematics education, e.g., STAN, MAN, MAG, GAST, should be fully involved in the development of national strategies for INSET for STM Tutors.

REFERENCES

Gibbs and Mutunga (1991), *Health into Mathematics*. Longman, Harlow, UK

Mary Harris (1992) *Improving the Quality of Science and Mathematics Education - the Role of Higher Education*. Commonwealth Secretariat, London, UK.

DO WE PRACTICE WHAT WE PREACH?

OR

Should We Change Our Practice or Our Sermon

Mr Mike Savage

WHERE DO WE STAND?

Oxygen is necessary for burning. It is one fifth of the air around. Things expand when they are heated. These facts are part of every educated person's culture, wherever she or he may live.

Over ninety percent of teachers demonstrate the truth of these facts, or at least make pupils copy the appropriate diagram from the chalk-board. They do so by placing a glass or similar container over a burning candle that stands in a dish of water. The candle goes out, water rises in the glass. If the experiment is done properly and good measurements made, the water rise is one fifth of the volume of the glass. If it is not, the experiment hasn't worked properly. Try again until it does or blame the faulty, locally made apparatus.

Many people call this science. Many people would call the demonstration that I have described, good teaching. Unfortunately both the science and the teaching are mostly rubbish. More unfortunately, much of what goes on in our schools in the name of science teaching is mostly rubbish and I'm not restricting my comments to Africa. Since my background is science, I have focussed my paper on science. Perhaps what I say is also true of technology and mathematics.

As leading science educators, we should be honest and admit when we are promulgating rubbish, or try to do something about it.

WHAT IS SCIENCE?

Why is what I've described not science and mostly rubbish? Do the experiment and actually observe what happens. Try using two or more candles; doing so shouldn't affect the result. But does it?

Part of the problem is that so few of us, whether we are university professors or primary school teachers have ever done most of what we lecture about, except perhaps when we were being taught ourselves. When we find ourselves lecturing too much we say our teaching is becoming too "theoretical" and try to introduce some "practicals". Unfortunately both our "theory" and our "practice" too often has little to do with the scientist's use of these words as Shaaban S Mohammed points out in his paper, "Science Camps for Children: A Model for Curriculum Renewal and Change". To scientists, theory, means an active intellectual search for meaning that uses experimentation (practicals) in an integrated fashion to better understand their world. To most science educators, theory means passing on the fruits of others' learning, and practical work means that students should follow instructions to establish the one so-called correct answer. To continue to do what we have been doing may be acceptable in the circumstances of our schools in Africa, but we must be aware of the fundamental misrepresentations we promulgate. Perhaps we should not call what goes on in our schools science.

To me, science is what we do to try to understand the burning candle. As Jos Elsgeest once put it, science lies between the question and the answer. The search may entail using all those scientific process we know so well. It may entail heated debate with others. It may entail a critical reading of books and articles. But whatever, I claim that science is the search. (Have you figured out what's going on with the burning candle? Can you convince me?)

WHY SHOULD STUDENTS LEARN SCIENCE ANYWAY?

That the teacher, syllabus and so on says so are too trivial answers. So are answers such as to pass examinations, get a good job, or to earn lots of money. Examples of more sophisticated answers are to train citizens that can make rational decisions, contribute to national development, and so on. Every policy statements have such justifications.

I think we should all try to answer the questions about ourselves. I hated science and learned it at secondary school and university only because I was expected to follow the family tradition and become a doctor. Neither I nor my family were in any way interested in the content. We were only interested in the results. Had the syllabus been restricted to anatomy of nematode worms, that would have been fine with us as long as the universities and society recognised the examination certificate. I often ask myself whether the science I learned is of any use in my daily life and frankly, I cannot remember using any in the last six months, except of course when I'm teaching. I suspect that most people's answers would be similar to my own.

I learned some subjects at school because I enjoyed them and was good at them. Those subjects captured my mind; they entertained me as much as going to the movies or the disco. Fortunately, since leaving university I have come to enjoy learning science in the same sort of way. I am fortunate that the skills I have developed as a result of this enjoyment earn me good money in a well paid, and respected job.

I claim that children should learn science, indeed any subject, because it stretches their minds, in the way that learning some subjects stretched my own. Students learning should stimulate their creativity and give them maximum excitement. When I read policy statements that science contributes to economic and national development, I smile as I think of the boom economies of the Far East based upon the nimble fingers of uneducated, adolescent girls.

"Science is doing the damnest with one's mind; no holds barred."
Peter Medewar, Nobel Laureate

HOW DO WE LEARN SCIENCE

If we believe that science is remembering other's theories together with recipes for performing specified practicals, then probably rote memorisation is a fine way to learn the subject; that is if one has a good memory. Rote learning probably works even if one already has conflicting conceptual structures developed as a result of living in one's particular cultural environment. Everybody acts schizophrenically at moments and we all have our own experience of this. For example, I still smoke cigarettes. But even if we believe science is only a matter of applying others theories is a new situation, or trying to experiment to find out something we don't already know, rote learning becomes problematic (**Have you solved the candle problem yet?**). If we do, maybe we have to consider teaching/learning approaches based on constructivist learning theories.

Analysing the way I learn myself, I know that often it takes me some time to even see the problem (**Have you noticed yet what happens if you use more than one candle? Does this pose problems applying your hypothesis?**). As the constructivists say, I have to use my own conceptual frameworks to try to explain new phenomena that I observe (My theory that the water rises to take the place of the oxygen consumed is not adequate to explain what I observe when I use more than one candle. But then again, I do live in a country with amazing distance runners. Perhaps Kenyan air is richer in oxygen).

Personally, I don't think that even constructivist learning theories, and classroom practice derived from them is enough to encourage scientific creativity. Again being personal since I know myself better than I know anybody else, I confess that I have to be highly motivated to learn: I have to be trapped by a problem if I'm really going to stubbornly work at it to my satisfaction, - rather than to the satisfaction of the teacher or the syllabus. But probably more important, it has taken me a long time of exposure to investigating puzzles such as the candle burning to become addicted to behaving scientifically. I have become better at seeing problems, puzzles and marvels all around me. Since I've used shorthand throughout this paper, let me use the phrase inquiring learning to communicate what I think is necessary to nurture this frame of mind.

WHAT SHOULD TEACHERS KNOW TO TEACH INQUIRY SCIENCE

Nobody who has never engaged in inquiry science should teach it (I once spent six weeks, many hours each day, burning candles and thinking about it). You have to experience the excitement, the frustration of one's hypotheses being inadequate, the boring repetitive work, one's own apparent stupidity and limitations, the need to become systematic, measure accurately, predict and design experiments to test the predictions, the appreciation of others' elegant solutions, the self confidence to continue. I would call this content and Shaaban S. Mohammed's paper has more to say about learning content. I would not call content adding yet more information to the information students have that has already proved inadequate to make them good teachers. Why add to what has already demonstrably failed? But I do not rule out consolidating what students know by having them apply their knowledge in problem solving situations, or to add to it as their expanding conceptual frameworks demand.

Secondly, nobody should teach inquiry science who has not reflected about learning. For a start, I think that students should be reflective and analytical about how they themselves learn. I think that students should work with children to learn more at first hand about how they learn (Part of the six weeks I spent burning candles was with a couple of children in their fourth year of primary school and I now know something of how kids of that age think about phenomenon. This was in the days of Piaget. In the era of constructivism, I should have done this work in classrooms). I would call this educational psychology and Richard Hodzi and Anamuah-Mensah have more to say about educational psychology. I do not mean the standard educational psychology courses, - the tour of Piaget, Vygotsky, Driver et al. Again, I would not rule out study about them, but only after students have developed their own groping understandings of how children learn.

Thirdly, nobody should teach inquiry science without serving an apprenticeship in classrooms. (I spent may hours working with another researcher in a Standard IV class learning how to teach about burning candles). Students have to learn how to trap kids into work on phenomena. They too learn how to ask the right question and when not to interact. Students have to learn how to manage forty children busily at work. They have to learn when most of the class are ready to benefit from a classroom discussion, scientists theories of the problem and so on. Teaching is a craft, like carpentry, that can best be learned by practice, hopefully in the company of crafts people. I would call this pedagogy or teaching methods and Mohammed, Hodzi, Gonthi and Anamuah-Mensah have more to say about pedagogy. I do not regard pedagogy is best learned directly by working in schools and indirectly by being taught in a style that the teacher is advocating.

Educating student teachers the way that I advocate raises problems of time, of access to children, and of access to classrooms and experienced teachers to act as mentors. Problems of time relate to the syllabuses and examinations which can be changed. I have never found access to children or classrooms a problem in Africa, nor have I found changing syllabuses and examinations an insurmountable task. Perhaps the problem is one of will.

HOW SHOULD TEACHERS LEARN HOW TO TEACH INQUIRY SCIENCE?

I have more or less discussed this issue in the preceding paragraphs. Teachers should learn the science content by being asked themselves to engage in inquiry. They should learn the necessary learning theory by working with children and the pedagogy by reflective, experimental teaching in classrooms. Teachers' education should empower them to make good classroom judgments.

WHAT TO DO ABOUT TEACHERS ALREADY IN THE SCHOOLS?

Practising teachers already know a lot. They know their children, their home culture, their environment, their interests and so on. More important, they know in their bones how lifeless, boring and unsatisfying teaching can be. More so that students, practising teachers respond positively when they see their pupils interested and actively engaged with their own learning. I have seen practising teachers become excited over, and over again in every English speaking country in Africa, except the Gambia and South Africa where I have not worked. Certainly, teachers also always complain about syllabuses, inspectors, examinations and so on but those are our problems as policy makers and not theirs. Having tasted inquiry learning and teaching, in my experience, teachers become strongly motivated.

Any in-service teacher education programme that ignores what teachers know, does so at its peril. Top-down models of in-service education, - where "experts" run training workshops for "ignorant, unqualified teachers" have failed everywhere in the world where they have been tried. "Experts'" increasingly frenzied efforts to pack more into courses, develop more streamlined methods and use modern media to impart their "expertise" have also failed. However effectively we communicate our message, unless teachers are motivated to change and are given some investment in doing so, in our absence they will do what they have always done when they return to their classrooms.

Such motivation and investment can be given if those of us involved in in-service teacher education realise that teachers are our colleagues and in some respects our professional superiors. We should strive for a collegiate relationship. We know more about some things than they do, but they know more about other things than we do. Practising teachers must also be exposed to learning about aspects of their environment through inquiry; to finding out first hand how children think about certain topics; and have the luxury of experimenting with a variety of teaching methods and reflecting on what they do. Clusters of practising teachers need support structure, where they can meet regularly. Teachers need access to others with more specialised skills, to relevant literature, even sometimes to technologies such as typewriters and word processors that will enable them to produce their own teaching/learning materials. Teachers need liberating from limiting syllabuses, examinations and tradition bound inspectors.

Shaaban S. Mohammed is involved with a group doing this in Zanzibar; Richard Hodzi in Zimbabwe, soon Anamuah-Mensah will be in Ghana. They are not alone.

To end on a more sombre note. In Africa today, when increasingly salaries buy less and less, I find it heartening that teachers are prepared to make any personal investment whatsoever in their professional growth.

INTERACTIVE TEACHING IN PRIMARY SCIENCE

Dr R A Hodzi

ABSTRACT

Primary science is not just a matter of knowing and making sense of the world; there is an equally emphatic goal of helping children to behave as scientists in the world. While both aspects are important and relevant to science in the primary school, the distinction between conceptual understanding and procedural knowledge is a fundamental and useful one. Conceptual understanding is concerned with the ideas of science; concepts such as what is a plant and what distinguishes plants from animals. What is sound, how it is generated, how it travels, how the human ear receives sound energy.

Scientific concepts are more than isolated 'facts' in the sense that they may be ideas about quite complex relationships between things. On the other hand, science processes describe the ways of behaving scientifically. We might describe most of our daily behaviour as "common-sensical"...with judgements made for "here and now"; scientific judgments attempt to embody greater generality. This paper presents with no claim completeness - some ideas about learning and teaching science at primary level that enable children to make sense of their world.

INTRODUCTION

Children have to construct their own meaning regardless of how clearly teachers or books tell them things, mostly, a child does this by connecting new information and concepts to what he or she already believes. Concept - the essential limits of human thought that do not have multiple links with how a child thinks about the world are not likely to remembered. Concepts are learned best when they are encountered in a variety of contexts and expressed in a variety of ways, for that ensures that there are more opportunities for them to become embedded in a child's knowledge system.

Effective learning often requires more than just making multiple connections of new ideas to old ones; it sometimes requires that children restructure their thinking radically. That is, to incorporate some new ideas, learners must change the connections among the things they already know, or even discard some long-held belief about the world. The alternatives to the necessary restructuring are to distort the new information to fit their old ideas or to reject the new information entirely. Children come to school with their own ideas, some current and some not, about almost every topic they are likely to encounter. If their intuition and misconceptions are ignored or dismissed out of hand, their original beliefs are likely to win out in the long run, even though they may give the test answers their teachers want. More centralization is not sufficient. Children must be encouraged to develop new views by seeing how such views help them make better sense of the world.

It needs to be kept in mind that the purpose of science education at any level is to help children make better sense of their world. Unfortunately, this does not always happen.

The question children are to consider, and the investigations they are to carry out, are usually selected by the teacher or teacher guided material, but not always with a clear understanding of the ideas children bring to the classroom. Even though a range of experiences may have been provided, when children's ideas are ignored the children frequently do not discover what it is expected they will discover or change their present ideas in anticipated ways. Some teachers are inclined to say, "well, obviously they are not ready for the ideas" or "we will have to tell them the scientists' view because it is something they need". In my view neither :

i) the selection of questions and investigations by teachers and curriculum developers without a real awareness of children's questions and ideas; nor

ii) the extreme views quoted about what is the teacher's role once children have been given an activity;

does justice to the potential abilities of either children or their teachers.

Cognitive research is revealing that even with what is taken to be good instruction, many students including academically talented ones, understand less than we think they do. With determination, students taking an examination are commonly able to identify what they have been told or what they have read; careful probing, however, often shows that their understanding is limited or distorted, if not altogether wrong. This finding suggests that parsimony is essential in setting out educational goals. In planning instruction teachers draw on a growing body of research knowledge about the nature of learning and on craft knowledge about teaching that has stood the test of time. Typically they consider the special characteristics of the material to be learned, the background of their pupils, and the conditions under which the teaching and learning are to take place. In order for teaching to be successful there are central needs to be considered and these include:

ACTIVITIES

Children need to have many and varied opportunities for collecting, sorting and cataloguing, observing, note taking, sketching, interviewing, polling and surveying. Classroom activities must take into account children's ideas and questions. Children need to get acquainted with the things around them including devices, organisms, materials, shapes and numbers and to observe them, collect them, handle them, describe them, become puzzled by them, ask questions about them, argue about them, and then to try to find answers to their questions.

COLLECTION AND USE OF EVIDENCE

Children should be given problems and at least appropriate to their maturity - that require them to decide what evidence is relevant and to offer their own interpretations of what the evidence mean. This puts a premium, just as science does, on careful observation and thoughtful analysis. Children need guidance, encouragement, and practice in collecting, sorting and analyzing evidence and in building arguments based on it.

CONCLUSION

In making conclusions there is need to ensure that children are neither left to their own devices to form their own conclusions, nor forced to accept "scientific" conclusions that are often formed in technical language and cannot be related to the child's personal experience within or outside the classroom.

Research has shown that attempts have been made in exploring ways that would make children make sense of their ways. The one that appeals to me is interactive teaching. Interactive teaching is based upon the following:

1. from a young age, children try to make sense of their world and not infrequently already hold ideas about a topic which a teacher intends to introduce;

2. the ideas which children hold about a topic are not necessarily those held by experts, but to the children they can be sensible and useful. When children are tying to understand a topic children will draw on their ideas about the topic, or on other ideas which they think might help them, and such ideas can influence their learning in significant ways;

3. scientific knowledge based on our history and culture is something which is neither simply transmitted from teacher to pupil, nor naturally developed from experience alone. Pupils and teacher must interact and discuss ideas derived from common experiences, investigations, reading books, and asking experts. It is in these ways that children construct more complete, effective and useful ideas than the ones they currently hold;

4. various skills (intellectual processes), particularly those relating to questioning and investigation, are important means by which children can make better sense of their world but children usually need help to develop such skills. Help will be most effective if given at the time when children see the need for specific skills.

5. children can begin to take responsibility for their own learning but this requires an atmosphere where both teachers and pupils genuinely care about and respect each other's ideas, an atmosphere which encourages the children to freely and responsibly express their personal views. It also requires that the teachers help

the children separate their ideas from themselves so that questioning of ideas is no longer felt by the children to be a threat to self worth.

WHAT INTERACTIVE APPROACH TRIES TO DO

In my view interactive teaching is based on an interchange to talk among people who respect each other's ideas. From a teacher's point of view this begins with a genuine desire to know what a child thinks and why. The main purposes, therefore, of interactive approach to teaching include:

a) to identify children's present ideas and questions;

b) to provide children with stimulating experiences either to confront and explore those ideas or as a basis for developing ideas; in either case the experiences should help children raise questions;

c) to help children develop, clarify, modify, and extend their ideas through seeking answers to questions they are interested (or can be interested) in or through checking proposed answers;

d) to encourage children to reflect on how they came by an idea and whether it is a sensible and useful one;

e) to assist children develop the skills they need to ask better questions, plan and carry out investigation, and construct and communicate ideas;

f) to help children realize that explanations of why things behave the way they do are frequently not 'right' or 'wrong' but are rather consistent with the evidence or inconsistent, useful or less useful, plausible or not plausible, intelligible or not intelligible; and

g) to convey to children an awareness that their genuine ideas are valued.

MAJOR COMPONENT OF AN INTERACTIVE TEACHING APPROACH

An interactive teaching approach is more than a sensitive way of interacting with children during a series of science lessons. It also involves structuring a study in a way that enables teachers to interact positively with children and at the same time enables children to begin to take responsibility for their own learning. In practice the interactive teaching involves the following:

1. Invitation: Observe one's surroundings for points of curiosity
Ask questions
Consider possible responses to questions

		Note unexpected phenomena Identify situations where students' perceptions vary
2.	Exploration:	Engage in focussed play Brain-storm possible alternatives Look for information Experiment with materials Observe specific phenomena Design a model Collect and organise data Employ problem-solving strategies Select appropriate resources Discuss solutions with others Design and conduct experiments Evaluate choices Identify risks and consequences Define parameters of an investigation Analyze data
3.	Proposing Explanations and solutions	Communicate information and ideas Construct and explain a model Construct a new explanation Review and critique solutions Utilize peer evaluation Assemble multiple answers/solutions Determine appropriate closure Integrate a solution with existing knowledge and experiences
4.	Taking Action:	Make decisions Apply knowledge and skills Share information and ideas Ask new questions Develop products and promote ideas Use models and ideas to illicit discussion and acceptance by others Approach decision makers in society urging them to act in specific ways
5.	Reflection	In addition to conveying to children the feeling that their ideas are valued and that the teacher is not the source of all knowledge, the intention during this phase is to have the children reflect critically on their findings, to open their minds to further possible explanations and investigations, and to

consider alternative ways of communicating findings to others.

6. Evaluation

Both teacher and children need to be able to assess the value of the investigations. This means asking the question "How valuable was this set of lessons?"

When using interactive teaching, the teacher no longer plays central role but the child. The teacher, however, still has several effective roles which he can adopt in the course of interactive teaching and these include:

Facilitator of Learning

In this role the teacher tries to bring children and relevant resources together. The teacher can do this by directing children to a particular book or equipment.

Resource Person

At times the teacher may have information that a child is seeking. In that case the teacher can act as a resource person in the same way as a knowledgeable parent, expert or other member of the community.

Naive Fellow Investigator

In this role the teacher expresses ignorance of an explanation or situation. In a sense, the more genuine the ignorance and the more willing the teacher is to learn from the children the better.

Challenger of Ideas

Here the teacher deliberately but sensitively challenges those ideas expressed by the child which are inconsistent with evidence, not useful, not clear and so on. The challenges the teacher poses have the effect of revealing the children's commitment to their present views and perhaps help the children to clarify or reconsider their views. As a challenge of children's ideas a teacher should not always take children's responses at face value but should sensitively explore what they have in mind.

CONCLUSION

It is now widely recognized that the most effective and relevant science learning takes place through the process of solving problems that occur in, or are immediately 'connectable' to the life of the learner, rather than in contrived situations in a classroom. Learning in science must be based on the pupils' own knowledge and experience so that he/she can achieve real understanding. This means beginning with familiar objects and phenomena encountered in his/her world.

At primary level, it is quite possible, even with minimal apparatus, to embark on a programme of active enquiry, investigation and problem solving which provides experience of ways of handling evidence. Children can be encouraged to observe, raise questions for further enquiry, generate hypotheses, plan their investigations, record and present results, interpret data and so on. It is useful, whenever possible, for these activities to take place outside the classroom. Such an approach can promote the development of thinking pupils, who will become thinking citizens.

REFERENCES

Association for Science Education, University of Leeds (1990) *Children's Learning in Science Project.*

Biddup, F. and Osborne, R. (1984) *Making Sense of Our World.* Centre for Science and Mathematics Education Research, University of Waikato, New Zealand.

IBE-UNESCO 1987 *Science and Technology in the Primary School of Tomorrow*

Liverpool University Press (1990) *Primary SPACE Project Reports.*

UNESCO 1983 *New Trends in Primary School Science Education*, Vol I.,

UNESCO 1985 *The Training of Primary Science Educators - A Workshop Approach.* Science and Technology Education Series, No. 13.

UNESCO 1986 *The Teaching of Science and Technology in an Interdisciplinary Context.* Science and Technology Education Series, No. 19

SCIENCE AND TECHNOLOGY EDUCATION AND SOCIETY: BRIDGING THE GAP

Dr J. Anamuah-Mensah

ABSTRACT

Science and Technology have for a long time worked to alter societal values, economic progress and political systems. It is also recognized that pressing problems and issues affecting developing countries are related to the interfacing of science, technology and society. In addition, industries provide jobs for a substantial number of school leavers. There is also the recognition that scientific and technological literacy should form part of the basic education for all citizens in a democratic society where decisions have to be taken on issues bordering on science and technology.

Despite these, science and technology education have followed different pathways. Science education has not responded to the needs of the learners and the society. There has been a complete disregard for the many activities in the cultural environment. To bridge the gap two major approaches - 'institutional link arrangement' and curriculum materials development - have been used. The STAG project uses the curriculum development approach to develop resource materials for teachers and students. This project involves industry in the write up of industrial accounts which then go through workshops, trialling and publication.

After initial concerns and reservations some industries provided write ups. It is hoped that the project would empower industries to develop materials not only for the formal school system but also for public education purposes.

INTRODUCTION

Over the years, the two enterprises, science and technology have worked to reshape societal values, beliefs and concerns, influenced economic development and altered political systems. They have become powerful agents of social and economic change.

Despite this collective influence, science education and technology education have historically followed different pathways and remained as strange bed fellows; convergence has been the exception rather than the rule. Science education as the separate disciplines of physics, chemistry and biology have been offered in most cases to a particular group of students while technical education has been reserved for the generally less academically oriented group of students. Even where students have the opportunity to take both science and technology courses the interconnectedness of science and technology have not been made visible.

NATURE OF SCIENCE AND TECHNOLOGY

Science has been defined in different ways by different people.

It has been viewed as a way of seeking information and also as accumulated knowledge resulting from this search. In general science is thought of as being concerned with the generation of new knowledge and understanding (Gardner, 1993). Technology, on the other hand, has been seen to be concerned with the production and improvement of artefacts, systems and procedures to meet human needs and desires (Gardner, 1993) and not simply as a collection of artefacts, however sophisticated and complex they may be.

Another view of technology suggests that 'technology can be characterised as that form of cultural activity devoted to the production or transformation of material objects, or to the creation of procedural systems, in order to expand the realm of human possibility (Hannay and McGinn, 1980).

(Gardner, 1993) argues that the view that technology is the application of scientific knowledge (although supported by historical developments) should be seen as one of four philosophical positions concerned with the relationship between science and technology; and that "no one position provides an account of science-technology relationships which holds true for all cases over all historical periods". The other philosophical positions are: science and technology as distinct fields, technology as procursor of science and the interactionist view of science and technology.

For many people today, there is little distinction between science and technology. The two have become closely knitted together such that they are inseparable.

Technologists have tended to use scientific methods of research to develop and improve their products thus making it difficult to determine where science ends and technology begins. Thus, in situations where, for example, parasitic proteins are analysed with the ultimate aim of preparing a sheep vaccine or grafting qualities of certain plants are investigated for the purpose of producing fast growing cassava species, there is obviously a problem of divisibility of the two enterprises.

However, in the school curriculum, we manage to separate them in such a way that they lose their interconnectedness leaving science education to be devoid of relevance for the student and his community.

THE SOCIAL CONTEXT OF SCIENCE - TECHNOLOGY EDUCATION

There is a growing concern that science education programmes have for a long time not been seen as responding to the needs of the learners and the society at large. This concern for qualitative improvement began about three decades ago and has now reached a crisis dimension (Yager, 1992; Gaskell, 1982).

In Ghana and Africa in general, the science taught in school has been closely linked to outmoded examination syllabuses which emphasize memorization of facts and principles (Towse and Anamuah-Mensah, 1991). The "chalk and talk" method has become the most widely used method of teaching science. Textbooks and other written materials such as model answer books and past questions continue to wield excessive power over both teachers and students. In United States, Yager 1992, reports that 90% of all science teachers use a textbook in excess of 90% of the time while Goldstein 1978 points out that students use textbooks for up to 75% of the time they spend in class and up to 90% of the time they work at home. In Ghanaian schools where written materials are highly valued, the percentage will be much higher.

Another concern is that science education has been pursued with no regard to the rich cultural environment with its many activities and practices. Science is thus regarded to be culture-free. Students graduate from science education programmes without being able to change fuses; connect wires to plugs or carry out other such activities.

A way out of this crisis for science education to be responsive to personal goals of learners and the changing needs and values of society has been found in the science-technology and society framework. The current reforms in the Ghanaian educational system including the science syllabuses, place emphasis on science, technology and society issues.

THE NEED FOR SCIENCE-TECHNOLOGY-SOCIETY IN SCIENCE CURRICULUM

The choice of science, technology and society framework in the science curriculum has been rationalised in many ways. Some of these are as follows:

Science and technology influence economic development and bring about new social values and arrangements. They therefore have a great impact on society. On the other hand, the activities of scientists and technologists are also influenced to a large extent by society. For example, society's unwillingness to fund research and development activities in certain areas is more than likely to curtail work in these areas.

Most of the pressing problems and issues affecting countries like Ghana are problems related to the interaction of science, technology and society. Some of the problems and issues of social value and population, health, nutrition, energy and environmental degradation which require literacy in science and technology.

Industries in Ghana provide work for a substantial percentage of school leavers who always get thrown into the industrial arena with very little knowledge about how the scientific concepts they have learnt in school can be used in the industry (Layton, 1989).

Currently, there is a world-wide recognition that scientific and technological literacy should form part of the foundation of basic education for all citizens. That means that in addition to reading, writing and numeracy, science and technology should be seen as basic to the survival of the human race. It should be seen to cut across all subject domains to provide people with the capacity to be responsive to a wide range of situations that confront them in their daily life. The world needs liberally educated people who can make informed decisions about science-technology-society issues. Studies have shown that the degree of scientific and technological literacy among high school graduates is very high (about 90%) and seems to be growing (Miller, 1989, quoted in Yager, 1993). This tendency needs to be arrested. There is also the realization that scientific and technological illiteracy exist among scientists and science and technology educators because of the high level of academic subject matter specialization granted by the educational system (Yager, 1993).

The democratic wind of change sweeping across many nations such as Ghana these days require the involvement of individuals in decision-making. Participation in democracy dictates that the general public be informed about science and technology (McConnel, 1982). This would enable them to participate in the making of appropriate choices and decisions. This is put more succinctly as follows:

> 'the very structure of a democratic society depends upon the existence of an enlightened citizenry. The political and social behaviour of this citizenry in voting, in influencing elective and appointive officials, and in engaging in political and social activism will be more constructive for society if it is informed by solid scientific understanding' (Trachtman, 1981).

The question of relevance is another issue which has been debated in educational circles for a long time. Relevance can be viewed as how useful the content of learning is to the individual himself as well as to the nation. The learning should be such that it can be applied to solving problems in the everyday life of the individual.

The gap that exist between science taught in schools and that encountered in the 'real' world outside especially in industry has been of major concern to many science educators and governments.

BRIDGING THE GAP

In many countries in the world, attempts have been made to close the yawning communication gap that characterises the interconnection of science, technology and society.

These attempts can be classified into those that involve the production of curicula materials for use in the classroom and those involving 'institutional link arrangements'. The 'institutional link arrangements' include visits to industries by students (Bello, Fiffe, Sanfeliz, 1992), work experience in industry or research laboratory for both teachers and students (Tam, 1985), and involvement of students in research projects designed to solve industrial problems (Kanhsuwan, 1986). Other link arrangements are: the institution of a fund by industries to assist science students and inclusion of industrialists on school science boards (Tam, 1985).

Attempts involving the development of curicula materials and syllabuses with technological (industrial) slant have been designed using the 'science-first' approach or 'applications-first' approach. The 'science-first' approach involves building relevant applications or issues into already existing science curicula materials. Thus, one might teach principles of electrolysis and then bring in the extraction of aluminium to show its application.

The 'applications-first' approach starts with applications or science-related issues from which the relevant science is developed. For example, one might begin with soap manufacture and develop from it scientific ideas such as saponification, bleaching, decolorization, salting out and alkaline hydrolysis.

These curicula approaches are exemplified by some recent curicula materials. The Science and Technology in Society (SATIS) materials (Holman, 1987) developed by the Association of Science Education, in the United Kingdom uses the 'science-first' approach to add relevant applications or issues to concepts in existing science courses. The Science in Ghanaian Society (SGS) project developed in the Department of Science Education of the University of Cape Coast offers applications of science from traditional industries such as palmwine tapping (Yakubu, 1984).

The Salter's Advanced Chemistry developed at the University of York in Britain (Waddington, 1992) and the CHECOM materials developed in the United States (Ware, et al, 1986) use the 'applications-first' approach to select applications and issues from which the chemistry to be taught is determined.

It seems, however that just like the curriculum development projects in the 60s and 70s, the development of materials based on the science, technology and society framework seems to have been "discussed almost exclusively within the educational community, with little contribution from those in the wider world of work". (Towse and Anamuah-Mensah, 1991).

Perhaps other interested parties with particular expertise should be allowed to participate in formulating goals and developing curicula materials for school science education. Teachers may develop curicula materials based on the interaction of science, technology and society. But these may be grossly over simplified because the teachers themselves have little or no industrial and technological experience (Holman, 1987) to help them to place science in its technological context. Industrialists, however, have the 'expertise, and can provide needed technological knowledge'. The teaches are familiar with the scientific concepts taught in school and also know about the capabilities and interests of their students as well as how learning takes place. Thus, working together the two groups can make the interaction of science and technology with society visible and authentic.

The Science and Technology in Action in Ghana (STAG) project based in the Department of Science Education, University of Cape Coast is attempting in a small way to build bridges over the gap between school science and the applications of science in industry. This is being done by involving industrialists as well as classroom teachers, university lecturers, researchers in research institutions, science subject associations and representatives of policy makers in the Ministry of Education in the development of curicula materials for use at the secondary school level. The industrialist as the 'expert' will initially write an account of his industry giving the stages in the production of goods and illustrating it with photographs, line drawings and flow diagrams. The accounts would then be studied and turned inside-out in order to weed out much of the technical language. The materials thus produced would then be used during workshops to develop 'teacher-friendly' materials which would be trialled, reviewed and finally published. During the workshop which would involve the participation of industrialists, science teachers among others, information on industrial output, industrial by-products and wastes and their environmental impact would be discussed.

At a later date student materials and videos on the industries would also be developed. The various stages are outlined int he figure below.

So far the first two stages have been executed for eight industries - paints, soaps and detergents, margarine, cement, word processing, soft drinks, cocoa and wheat flour.

It has not been easy getting people in industry to write an account of their enterprise. After initial contacts and visits, it took not less than five visits to get the industries to either write scanty or very technical accounts or to give an oral account. The oral accounts were vetted by personnel from the industry after transcription.

The industrialist had concerns which the project members tried to resolve. There was initial expression of lack of confidence or expertise in writing what can be used in the science classrooms. There was the concern about divulging industrial secrets which would-be competitors can capitalize on. Those who felt strongly about this decided to either not give any written account or give only oral account with or without a tours of the industry. Those who became satisfied with the explanations by the project personnel, wrote very elaborate and much useful account. Others not so well convinced gave scanty accounts which were educationally not useful (Anamuah-Mensah, 1993).

The teachers, on the other hand, doubted the capabilities of the industrialists to write materials that will match the level of their students. However, later on they began to be concerned with how they can transform the technical write-up of the industrialist into a less technical account.

It seems that the industrialists after their initial reluctance became interested in sharing their knowledge which has always remained their own property, in fact a 'secret', with teachers. This is laudable as it will serve (if developed further) not only to open the communication channels between the two groups but also help in bringing industry into the science classroom thereby bridging the gap.

It is hoped that when funding becomes available, other industries would be included and workshops held to develop the final resource materials. It is also hoped that the group dynamics during the workshops would be studied so as to get an insight into the changing concerns of the different groups. In addition, it is expected that the contacts established between industry and school will develop to include 'institutional link arrangement'.

Finally, it is hoped that the project will serve to empower industries to produce materials (not only for the formal school system but) to promote public education and offer a balanced view about industries.

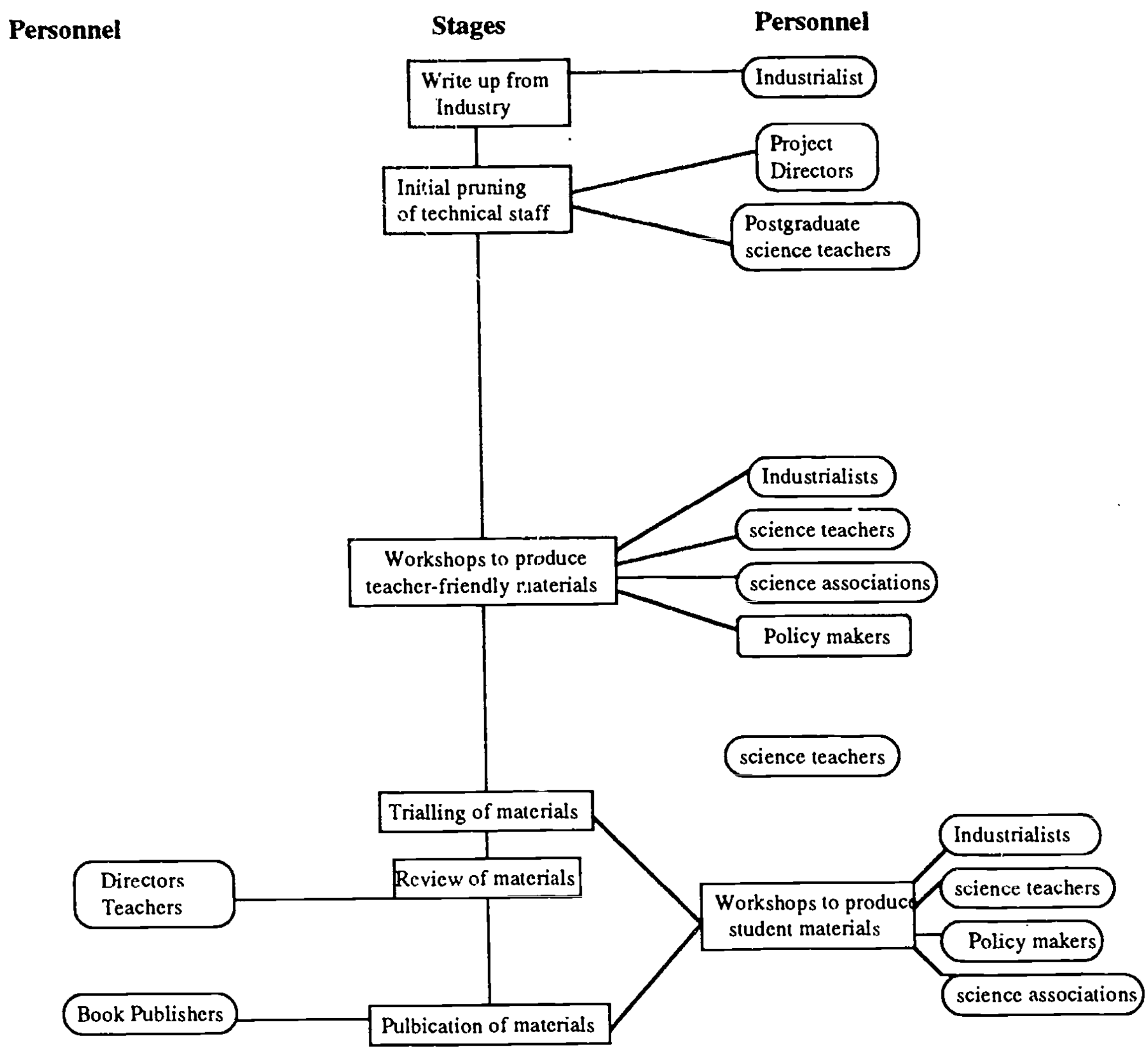


Figure: Stages and personnel involved in the development of industry-based materials

REFERENCES

Anamuah-Mensah, J. (1993). *Bringing Industry into the Science Classroom: Problems, Concerns and Prospects.* Unpublished.

Bello, L. J., Fiffe, N. and Sanfeliz, P. (1992) *How do we Link Industry to the Chemistry Curriculum.* International Newsletter on Chemical Education, 37, 8-9.

Gardner, P. L. (January 1993) *Science and Technology: Rethinking the Relationship.* A paper presented at International Conference on Science Education in developing Countries: From Theory to Practice. Jerusalem, Israel.

Gaskell, P. J. (1982) *Science Education for Citizens: Perspectives and Issues. Science, Technology and Society: Issues for Science Teachers.* Studies in Science Education, 9, 34-46.

Goldstein, P. (1978). *Changing the American Textbook* Lexington, Massachusetts: D. C. Health.

Hannay, N. B. and McGinn, R. E. (1980). *The Anatomy of Modern Technology: Prolegomenon to an Improved Public Policy for the Social Management of Technology.* Daedalus, 109 (1).

Holman, J. (1987) *Introducing Industry and Technology to the Secondary Science Curriculum: The SATIS Approach.* International Newsletter on Chemical Education, 27, 9-11.

Kanhasuwan, L. (1986) *Teaching Industrial Issues in Secondary Schools.* International Newsletter on Chemical Education, 26, 5-7.

Layton. D. (1989). *Science Education and Praxis: the Relationship of School Science to Practical Action.* Studies in Science Education, 19, 43 - 79.

McConnell, M. C. (1982) *Teaching About Science, Technology and Society at the Secondary School Level in the United States. An Educational Dilemma for the 1980s.* Studies in Science Education, 9, 1 - 32.

Miller, J. D. (1989, April) *Scientific Literacy.* Paper presented at the Meeting of the American Association for the Advancement of Science. San Francisco, California.

Tam, P. (1985). *Closer Ties Seen Between Chemical Education and Industry in Developing Countries - A Move in the Right Direction.* International Newsletter on Chemical Education, 24, 16 - 17.

Towse, P. and Anamuah-Mensah, J. (1991). *Science and Technology in Action in Ghana.* Science Education International, June 31 - 34.

Trachtman, L. E. (1981). *The Public Understanding of Science Effort. A Critique.* Science, Technology and Human Values, 6, (36).

Waddington, D. J. (1992). *Chemical Ideas and the Environment.* International Newsletter on Chemical Education, 38, 15 - 18.

Ware, S. A. Heikkinen, H and Pippincott, W. T. (986). *The CHEMCOM Philosophy and Approach.* International Newsletter on Chemical Education, 26, 10-12.

Yager, R. E. (1992). *Viewpoint: What We did not Learn from the 60s about Science Curriculum Reform.* Journal of Research in Science Teaching, 29 (8), 905 - 910.

Yakubu, J. M. (1984) *Science in Ghanaian Society: Teacher's Guide.* Faculty of Education, University of Cape Coast

VIDEO AND TEACHER EDUCATION: PRIMARY SCHOOL SCIENCE VIDEO TEACHER EDUCATION IN MALAWI

Harold F Gonthi

INTRODUCTION

In August 1985, the Committee on the Teaching of Science of the International Council of Science Unions, organised a conference in Bangalore, India, on Science and Technology Education and Future Human Needs. The Committee received considerable support of Unesco and the United Nations University.

Corridor discussions at the conference led Vincent Gondwe from Malawi and Gary Knamiller from the University of Leeds, England to consider the possibility of using video for science education.

As a follow-up activity to the Bangalore conference, the two met at the University of Leeds to examine the idea of using video for science education in a more systematic manner. They mapped out the basic approach which started with demonstrating how school science is linked to community science and technology.

Kawaza, a rural village community in Malawi was chosen for this purpose with the assistance of the University of Leeds.

Gondwe and Knamiller took a video tape shot on the life in the Kawaza village. The edited 31 minute long tape shows science-rich technology activities forming part of the daily working lives of the villagers - parents and their children. The commentary urges the audience to consider other such examples in school children's experiences and to think of ways of building on them to make school science and technology meaningful. Thus the Linking Community Science and Technology with School Science Project - a Primary School Science Teacher Education Video tape Project was borne.

The project is a collaborative effort involving science educators from the University of Leeds and an education institution in Malawi, namely Malawi Institute of Education - the coordinating institution, the Ministry of Education and Culture - supporting the project at the ministerial level, the Malawi National Examinations Board - responsible for examinations, and teachers colleges for primary school teachers.

In 1989 a team of science educators from the University of Leeds and Malawi put together a series of lessons based largely on the content areas as addressed in the Kawaza tape. These lessons incorporate a variety of teaching techniques. The lessons were taught to children in two primary schools and were videotaped as the lessons unfolded.

The Africa Forum for Children's Literacy in Science and Technology, an activity of the Rockefeller Foundation is currently supporting the project.

HOW IS SCIENCE PERCEIVED BY CHILDREN IN SCHOOLS?

Some years ago when I was involved in a science UNESCO/UNDP curriculum development project, as a counterpart to a science curriculum specialist, we, just like other science educators in the world were talking about making science teaching and learning learner-centred. This consequently called for teaching styles that were different from the ones that were being used before - chalk and talk. I remember vividly the science specialist and I were talking to one senior person in the Ministry of Education who remarking about the teaching strategies we were trying to promote said, "why worry about all these new methods, just tell them". I guess the senior education officer believed in rote memorisation. But even rote learning becomes problematic. (Savage 1993, p4).

Most of us had perhaps gone through this kind of teaching. The teacher taught by telling, we were expected to learn by memorising. It is not surprising many of our colleagues including those of us who survived secondary science and later alone university science found science learning difficult. And I am reminded of my physics professor who used to assure us in the physics class that we were going to pass his examinations. After all, he would say, there are all those what are not taking physics - the fact that you are taking it means you can pass and he would mention areas he was going to base his tests on. All this was in an attempt to awaken our interest for physics.

In Malawi, as in many other countries, many children appear to find science difficult and often tedious. There are many causes, one of which is that described above. The other is they perceive the science which they learn in school as having little in common with their everyday lives. The concepts with which they wrestle in class are usually set in unfamiliar scientific contexts. Teaching approaches fail to recognise that pupils bring with them to school significant scientific and technological knowledge based on substantial experience from working with their parents and other adults in their homes and communities.

Teaching is rarely set within such areas of familiarity; indeed it is exceptional for teachers to take the time to find out and build upon children's existing scientific understandings. Additionally, beliefs or even misconceptions are seldom challenged.

Furthermore, teaching methods in science and technology are largely didactic with assessment subsequently emphasising recalling to the exclusion of other abilities which pupils might have.

The effect on children is ultimately demotivating. Science is seen as remote, hard and abstract. It holds so few attractions that few continue their study of science and technology when offered subject choice.

WHAT PROBLEMS DO TEACHERS MEET?

Teachers, particularly in primary schools, meet lots of problems. An interested observer would have a long list of the problems primary school teachers meet in the course of their profession. The most important problem which is often ignored is perhaps the lack of support. This lack of support manifests itself in many ways. Including - lack of moral support, material support as well as ideas they can tap upon.

A primary school teacher is lucky if s/he has a teaching syllabus, enough pupils' books and text books for reference. If the school has a library s/he is lucky if the school head opens it up for the teacher's use. Teacher in-service is rarely heard of. If there is one, the teachers are there to be lectured. Rarely are they allowed to share their frustrations with those who oversee them.

If we want teachers to teach effectively and enjoy their teaching profession, we must be seen to support them. Provision of teaching/learning materials is one way of supporting them.

THE PHILOSOPHY OF THE VIDEO TEACHER EDUCATION PROJECT

The major goal of the video teacher education project is to produce video tapes and support materials for use in the training of primary school teachers.

The materials are based on the central idea that Malawian children experience science and technology outside the school in their communities. They bring this extensive knowledge with them to science lessons in school. Therefore it is the job of the teachers to find out what the children already know and to use this as the basis for extending their (children's) knowledge of scientific concepts and acquisition of scientific skills.

In these video segments a variety of strategies are shown. They have been chosen for it is believed that they make the learning of science interesting, enjoyable and above all, effective. The strategies include the use of effective questioning, exploration, investigations, systematic observation, recording, evaluation of results, and group work. Thus, the project has concentrated its efforts on using activities that children experience in their everyday lives.

The aim is to show student teachers (STs) and provide them an opportunity to practise how to link community science and technology with school science so as to make science lessons for pupils more meaningful and interesting. The project believes that this can only be achieved by using **hands on** and **brains on** strategies shown in the video segments.

There are five packages each containing a video segment and written support materials. The video segments are **mosquitoes, mushrooms, mbaula-fuel, weevils and bricks.**

There is also a sixth resource package that focuses on assessing pupils' and STs understanding of the scientific skills that appear in the five video segments.

The project feels that it can not encourage new approaches to teaching and learning science in primary schools without also offering novel examples of how to assess pupils' knowledge and understanding. It is for this reason that the package on assessment had been developed.

The project recognizes the importance of assessing pupils' knowledge of scientific facts, skills and concepts. In this regard, the assessment package offers examples of good recall type questions which teachers can use across the five segments. However, emphasis has also been given in assessing pupils' activities in skills associated with carrying out scientific investigations. Thus the assessment package provides teachers with specific examples of questions that focus on **planning investigations, recording information, analysing data and making inferences** based on experimental evidence.

HOW TO USE THE PACKAGES

Each video segment shows a teacher carrying out model lessons related to a specific theme. The purpose of the videos are not meant to teach science knowledge content. For example, the mosquito video segment does not systematically present the life cycle of the mosquito. Nor does it list for STs various methods of controlling mosquitoes. It is assumed that STs already know this. The purpose of the video, as said earlier, is to demonstrate a variety of approaches to teaching science using pupils everyday experiences.

Before showing the video segment to the STs, the tutor is expected to prepare the STs to look for the main strategies employed in it. After this the STs should be shown the video segment in its entirety. Then, the video can be used again and again to demonstrate particular points that the tutor wants the STs to focus on. After that the STs should be asked to have demonstration lessons to teach in the similar way. Micro teaching lessons are recommended using both pupils and peer groups. The support materials make specific suggestions for extending activities that require STs to do the investigations presented in the video and ask questions to help pupils observe more critically and so on.

The tutor is expected not to do all the activities suggested. She is free to sample from them as best fits her/his existing programme. The videos are there to hopefully stimulate interest and awareness and to act as starting points for encouraging active learning by STs in the teaching of science to children using their everyday experiences.

The assessment package can be used on its own as a resource for teaching STs how to write good science questions. But perhaps the way to use it most effectively is together with the video segments and their support materials. The project advocates that STs relate these new ideas about teaching science to the process of assessing pupils' abilities in these areas. Indeed, the questions themselves can be used not only as examples of test items but also as interesting and challenging learning activities.

DOES THE VIDEO HAVE A CHANCE IN TEACHER EDUCATION IN MALAWI?

The potential of the use of video in teacher education is not new in Malawi. During the first phase of the UNESCO/UNDP curriculum development and teacher education project (1978-1982) video facilities were installed in three of the eight teachers colleges. Its potential was in its use in micro-teaching lessons. Few lessons by the STs were video-taped and the tapes were used for follow up discussions. Perhaps what was lacking was video tapes which were already made to suit the Malawian context. This is where these video tape series try to fill a gap.

Whereas the 'Kawaza' tape was edited and produced at the University of Leeds in England, the five video tape segments have been edited at Chancellor College - University of Malawi. Instead of sending two Malawian project team members to England to do the editing UNICEF provided the funding to install VHS video-tape editing facilities at the Audio Visual Centre - Chancellor College. This meant that project team members in Malawi were on hand to take an active part in editing, to say nothing of the other advantage of having the equipment in the country. The experience of developing the tapes provided an opportunity to a group of Malawian science educators to acquire knowledge and skills of making video-tapes for educational purposes.

INSET

If the idea of the project are to succeed the project recognises the importance of making the video project the colleges' own activity. Therefore holding **In-set** for the college tutors before the video tapes are distributed to the colleges is one of the major activities.

Two types of In-set will be held. The first will be for the key college science tutors. This will be conducted by the project team members. The key tutors will be called to the Malawi Institute of Education for at least 5 days. They will be provided an opportunity to view the tapes and get acquainted with the project philosophy and ideas, identify weaknesses and potentials of the materials. In the second **In-set**, the key college science tutors will take over from the project team members in orienting their colleagues in the colleges. This IN-SET will be college based.

CONCLUSION

In conclusion, the video teacher education project aims at:

- alerting primary school teachers, student teachers, college tutors and other educators to the science and technology experienced by school children in their home communities.
- showing that such scientific experience relates also to school science and to the knowledge and skills valued.
- demonstrating that there is a variety of teaching approaches which can be used to exploit and challenge children's existing knowledge while developing their understanding of abstract concepts and scientific skills.
- showing that such approaches engender an enthusiasm for science in children because they
  - can see the relevance of taught science to the lives outside school and
  - are more actively involved in their own learning.

Since, in the words of Professor Bajah, this is not a 'talkshop' I invite you to watch a selected theme of the project products and hope you will give your constructive criticisms which will be useful for the improvement of the project.

The paper has not tried to dwell on the successes or failures of the project. The paper has concentrated on what is currently happening in an attempt to improve the quality of science and technology education in Malawi.

PARTICIPATING IN SCIENCE EDUCATION RESEARCH

Dr Gilbert O. M. Onwu

INTRODUCTION

Educational research is recognised the world over as one of the most effective means of obtaining objective solutions to educational problems, and arguably the only sound basis for effecting educational improvements. It is indeed becoming increasingly accepted as a critical element in the multifarious educational activities aimed at improving the quality of education provided at whatever level.

In this paper an attempt will be made to outline what is believed to be some of the major implications for the improvement of the quality of science education at the basic level emerging from science education research and development. Stated briefly, our position is that science education research and development ought to belong to the teacher (both as a user and as an initiator) - and that there are prospects of making this good in practice. The teacher is the most important resource in science education. No one can lay claim to the same degree of familiarity with classroom conditions that he has. Furthermore, the first indications of success or failure in implementing the curriculum are first known to him, and if that is the case, he must of necessity be equipped with those requisite skills of research (including the appropriate research perspectives and motivation) in his professional development that would enable him to further sustain or enhance the quality of education he provides.

RESEARCH AND PROFESSIONAL DEVELOPMENT OF THE SCIENCE TEACHER

Professional development is something that each science teacher must be involved in - this includes considering one's needs, making decisions about how changes or modifications will occur in some aspects of classroom practice in order to improve learning and evaluating their effectiveness.

In consequence, professional self-development means for the science teacher:

(i) the commitment to the systematic questioning of his own teaching, i.e., what he does, how he does it and the consequences of his doing it;

(ii) the commitment and skills to study his own teaching including the work of other teachers or practitioners in the same field; i.e. knowing how to examine and analyse classroom procedures;

(iii) the concern to question and to test ideas by classroom research procedures.

In short, improvement in the quality of science education depends to a large extent on the capacity of teachers to take a research stance to their own teaching. This means a disposition to examine their own practice critically and systematically (in the light of research findings) in order to improve their teaching.

In general, the aspects of "feedback mechanisms", "resource and support", and techniques for classroom study which are considered important for successful implementation of programmes and for autonomous professional self-development are alas the ones that seem to be lacking in our science teacher training programmes in colleges of education.

The pre-service training programmes in our colleges of education while emphasising certain aspects of the academic and professional components of science teacher education would seem not to have given adequate attention to the research element of teacher professionalism. Pre-service education has a part to play no doubt in addressing some of the issues, but what is needed is a recognition of the role teacher participation in science education research can play in improving teaching and learning.

WHAT IS SCIENCE EDUCATION RESEARCH?

Science education is about the teaching and learning of science wherever it takes place (at primary, secondary or tertiary level; in industry or in the home).

Science education research is broadly defined here to include any activities that lead to a better understanding of science education problems and that produce findings relevant to programme planning and implementation and/or policy formulation. "Research then includes any activity involving information gathering and analysis from the simplest to the most sophisticated operation" (IDRC).

Students, teachers, curriculum developers and education officials can be considered as research users and researchers. There are people who use exiting knowledge of science education (students and teachers), there are people who develop new methods and approaches (teachers, writers, curriculum developers), and there are people who create new knowledge about the teaching and learning of science (researchers). As with other branches of science (science education is regarded as a branch of science), there are advantages when users developers and researchers work closely together or are even the same people.

To summarise. science education research is aimed at improving the teaching and learning of science, and consequently the researcher will usually also need either to be a developer or user (i.e. a science teacher) or at least be prepared to collaborate closely with science teachers.

We need to make the point however, that while accepting this broad definition of science educational research as appropriate for our immediate goal that of improving the quality of science education, it is neither being suggested that only research which has immediate usefulness or applicability is worthy of respect or support, nor that research in science education is in any way different from that in other subjects. Whether used or unused research - the intellectually honest pursuit and generation of new knowledge and ideas is an essential function of higher education, and where resources permit the acquisition of new knowledge for its own sake is a legitimate goal of educational research.

Thus research endeavour as conceptualised is not restricted to only the activities of scholars rather it is construed as a human activity involving a systematic way of thinking and behaving that leads to problem solving.

WHAT DOES RESEARCH SAY TO THE PRIMARY SCIENCE TEACHER?

Primary science is one of our more recent innovations in primary school education. Today, there has evolved a detailed teaching curriculum - a Core Curriculum for Primary Science delineating expected levels of attainment for precisely specified objectives. The aims of the curriculum are derived from a conceptual view of primary science as simply meaning developing in pupils through self-activity an enquiring mind and a scientific approach to problems. Teachers are expected to be faithful implementers of the intentions of the curriculum developers.

However, in reality observations of pupils and teachers' work in our science classrooms reveal that the intentions of the curriculum developers as contained in the curriculum specifications are often reinterpreted in ways to suit various classroom contexts and also as perceived by the teachers who have the ultimate responsibility of implementing the given curriculum. Teachers adapt the goals, objectives and content of the formal curricula to the specific classroom context. They routinely modify curricula by additions, deletions and changes in sequence and emphasis and often to the detriment of the intentions of the developers.

Part of the problem of the "omnipresent gap between intention and realisation" is that our teachers are often ill-prepared (sometimes through no fault of theirs) coming from inadequate subject back-ground, lacking the confidence to attempt non-instructional teaching in the useful methods of scientific enquiry, and indeed often badly tutored or briefed about how this kind of activity work would fit into the overall aims of science education. Overall these problems are if anything more acute in the primary sector where the foundations of an understanding of science is laid.

Given the problems serving science teachers face in translating the aims into action, and the important and far-reaching decisions they are required to make in carrying out managerial responsibility in the classroom, there is the need for them to be provided with opportunities to familiarise themselves with information on the curriculum and curriculum related issues that may suggest modifications and provide a focus for reflection to enable them take appropriate decisions.

This is where knowledge of research becomes relevant. By taking advantage of relevant research findings teachers can improve their ability to make professional decisions concerning how to successfully implement the curriculum.

In sum, what research has to say to the teacher may be constiued in terms of feedback which then provided focus for further reflection. Feedback is simply information about a process or experiment that may suggest that changes or adjustments would be desirable. The main purpose of reflection is to uncover assumptions or prevailing beliefs - to get one to think about one's thinking in order to improve. Let's illustrate with a case study.

CASE STUDY I

A recent study (Okeke and Inomesia 1986) investigated primary science teachers' perception of the teaching of primary science in two states of Nigeria.

The basic questions which the investigation attempted to answer were:

1. What proportion of the primary school teachers have the appropriate perception of the objectives of primary science?

2. What activity/activities during the teaching process do primary school teachers regard as good science teaching?

3. Do the primary school teachers consider primary science as taught now effective? If so why? And if not why not?

The results showed that:

(i) a high proportion of the 310 teachers from 50 schools used for the study demonstrated ignorance of the objectives of science teaching in primary schools. As high as 37.09% of the respondents were unable to state any meaningful objective for the teaching of primary science;

(ii) activities perceived by many of the teachers as indicative of good science teaching were predominantly teacher-centred activities. This is evident in the finding that activities peculiar to the teacher alone (talk and chalk method, teacher directed pupil reading of science books, teacher demonstration, etc.) accounted for 59.19% of all activities considered as indicative of good science teaching;

(iii) a good proportion of the teachers (64.5%) were of the view that the teaching of primary science as is presently done in our primary schools is not effective. And 25.8% of the teachers felt that the present teaching activities were alright. About 20% of the respondents were of the view that lack of interest on the part of the teachers and pupils is a strong factor contributing to the perceived ineffectiveness. Another factor which attracted 18.7% of the teachers' positive response is lack of qualified science teachers.

The findings of the study that the present teachers of primary science in Nigeria lack knowledge of objectives and methodology of primary science - even when the Core Curriculum for Primary Science has been published and in use - have great implications for science education at the basic level in the area of teacher education.

Speaking specifically on the aspect of interest in science, it is perhaps pertinent to note that where a teacher is interested in a subject there is the likelihood that he or she would take the trouble to initiate meaningful activities that would be predominantly child-centred aimed at generating and sustaining the child's interest in that subject. On the other hand, it could be argued that one tends to lack interest in what one does not adequately understand its purpose, objectives or goals. The poor knowledge exhibited by the teachers of the objectives of primary science may be the root cause for their lack of interest. Again, these teachers being class-based teach all subjects to their pupils including primary science, and this may well account for the finding that the teachers mostly talk to the children about science, using the traditional "telling" method, instead of engaging them in self-activities that would allow them to experience and do science.

The research has raised issues of teacher preparation and re-training workshops which when tackled can help in the improvement of the quality of science education at the basic level. The beneficiaries of such research should be the teachers themselves and teacher educators.

TEACHER AS A USER OF RESEARCH

Is contemporary research in science education any use? Most science teachers, whatever their level, will, I am afraid answer in the negative. The results of science education research do in fact remain largely unused.

This is probably because most of the work done in the area has relied on observers - science educators, higher degree students and their teachers, research workers, etc., rather than classroom teachers. And generally speaking these workers have been more interested in building and/or testing a theory of teaching and reporting findings in a form addressed mainly to the research community.

However, this is not true of all the work reported, but there are always indications or traces of the separation (alienation?) of the research worker (from outside) from the teacher.

But the issue of utilisation of research results by science teachers is informed, one suspects by certain factors. It all depends on

(i) teachers' attitude to information (whether it is thought relevant or not) and

(ii) the motivation to use available information.

To those two should be added, the manner or format or means by which information is communicated and the recipient's ability to comprehend or make sense of the information.

The views and attitudes of teachers towards educational research has been investigated in the Nigerian context (Ajayi 1982).

CASE STUDY II

The sample for the study comprised 175 graduate teachers (both professional and non-professional) and 20 headmasters drawn from 25 secondary schools located in three states in Nigeria.

The basic questions asked were:

1. What research would secondary school teachers and principals like to see done?

2. Do they think they benefit from the research works in education that have been undertaken?

3. Which is the best method for disseminating research findings to them?

4. How far have they been involved in research projects?

5. To what extent is educational research findings getting through to them?

Answers to these questions should provide some useful insight into the reasons behind the general apathy towards educational research and development in the country.

The findings showed that:

(i) A majority of the headmasters and teachers had unfavourable and unsavoury attitude towards educational research. While 33% showed a favourable attitude, 67% of the respondents displayed a negative attitude. Female teachers had unfavourable attitude than their male counterparts.

(ii) Most principals (85%) and teachers (91.4%) had little or no knowledge of the research findings that had been conducted in the field of education in the areas under study or in their areas of specialisation.

(iii) Most teachers (65%) and head masters (65%) would prefer research findings and recommendations being sent either to the Schools Board where teachers could easily have access to them or the summaries of such findings to the head of each institution (school), instead of the present system of reporting them only in journals or stacking them away in the University's library or the researcher's 'cooler'.

(iv) Teachers would prefer researches dealing with teacher training and welfare, teaching methods, and improvement of learning, in that order.

(v) The teachers also complained (in oral interviews) that research findings are published in journals that are not easily accessible to them and that the language and manner of reporting research findings are always too technical with the result that even when they bother to read them they seldom understand what is being said.

From the observations it is evident that research findings are not able to reach or penetrate practitioners in the classroom precisely because of a lack of communication between researchers on the one hand and the intended users on the other hand. Perhaps the simplest explanation is that science teachers do not read the published results and are not sufficiently research-minded to want to use them. Again some of the published research papers use a specialised language which busy teachers have neither the time, nor the inclination to learn. Sometimes this specialised language seems instead to obscure rather than enlighten.

COMMUNICATING RESEARCH FINDINGS

What action(s) might make science education research more useful to the teacher?

This is basically a question of communication and relevance. Perhaps when thinking about the criteria for determining what strategies or actions might make science education research relevant to the science teacher it may useful to ask and answer the following questions:

1. How do researchers see practitioners (teachers) and how do practitioners see researchers?

2. How relevant is the investigation to the teachers' and schools' needs?

3. How do we sensitize the teacher to the need for educational research?

4. What strategy should we evolve to involve schools in the identification of the problems for research?

5. How do we provide feedback to participating schools in a research, ensuring the capacity of the teachers to understand and utilise the information and the

possibility for interaction, as well as ensuring anonymity of schools, teachers and students?

6. How do we resolve conflicts arising from the perceptions of researchers and teachers?

STRATEGIES FOR BRIDGING THE COMMUNICATION GAP

To help teachers adopt a research-based approach to their teaching help can be given to broaden their view of science education research.

1. Pre-service and in-service activities are needed to help teachers define for themselves research problems and the meanings of action-research in the classroom.

2. Focus on ways of demonstrating research procedures and methods and results to science teachers:

    - Use findings through institutes and faculties of education of the universities - abstracting, reviewing and diffusing findings through in-service training, seminars and workshops.

    - Look at series of researches (on a subject basis) identify the trend, review the researches to identify common findings and develop a model which can then be recommended for use.

3. Address findings of research to School Boards, Ministries of Education, principals, etc., as the case may be.

4. Establish some cooperative acquisition and documentation schemes of result findings (on a subject basis) among institutes and faculties of education of universities, colleges of education, professional associations, etc.

    - Establish a service that distils from research communication, findings that are relevant to the classroom teacher.

5. Look at the possibility of setting up a national journal of science education research available to science teachers and lay audience. The purpose of such a journal would be:

    (i) to concentrate research results on a subject basis so that they would be read by science teachers.

    (ii) to provide an outlet for classroom based research (results would have no more applicability than those in traditional research journals but they would be more likely to stimulate other teachers into making their own investigations). In this regard teacher training institutions would need to encourage their students to undertake project work which should lead to research skills development.

(iii) to inform teachers about the methodology of classroom based research and to encourage them to do research. Finally more attention should be given to defining research problems. These must be relevant to the teachers and learners of science.

6. Organise workshops, in-service training and seminars designed to encourage user education and involvement of users in generating research information.

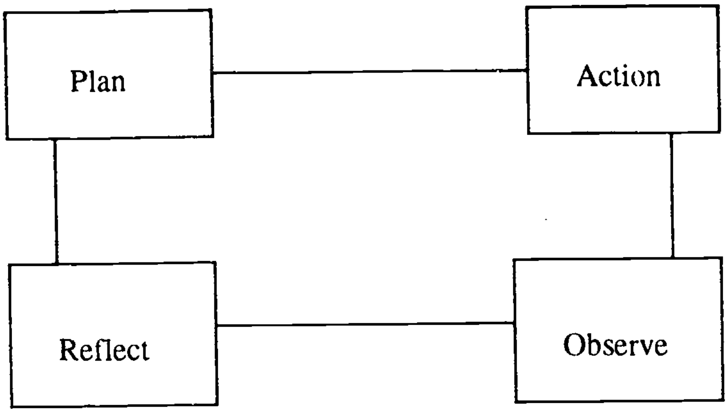
We hope that by doing all these we would have at least succeeded in getting information to the potential users. However the problem of utilisation still remains because this is primarily in the hands of the curriculum implementer - the teacher.

TEACHER AS DEVELOPER (RESEARCHER)

The science teacher viewed in this role is concerned to understand better his own classroom, to help make informed decisions before, during and after a lesson about teaching and learning activities, resources, assessment strategies and to improve the quality of education provided. It is not enough that the teacher's work should be studied they need to study it themselves. So the initial focus of developmental activities could address the things that the teacher does rather than what the student does.

When teachers are researchers or developers they are learners too. As a learner, the teacher has the responsibility of listening to students' ideas and language, of assessing his teaching approach, of interacting with people in the community and his professional colleagues, of locating local resources (people and materials) and of using them to enrich the curriculum so that the learning is useful and appropriate for the students. In effect, the teacher, in an informal way is an action-researcher as he or she is clarifying curriculum issues and problems, collecting data and information, using it to make informed decisions to improve the learning and so on.

A number of action-research models for development occur in the literature. Problem-solving projects are common forms of this type of activity. Action-research models usually involve a cycle of reflecting, planning, collecting data, trying out strategies, getting feedback, modifying plans and continuing on the cycle as summarised diagrammatically below:



We had earlier on indicated in this paper that reflection is one way for the teacher to obtain feedback for action or for further action. A science teacher working in this tradition could be regarded as sufficiently research-minded.

At the classroom level, reflection (which does not come naturally - it is a learned behaviour) takes three forms and they differ in when they occur.

Reflection - for - action

Reflection - on - action

Reflection - in - action

Reflection-for-action: Traditionally this has been thought of as planning but should include questions about "what will I do?" and "how will I do it?", "why am I doing it the way that I intend to do it?" and "what am I assuming?"

Reflection-on-actioon: This is essentially an evaluative type of reflection. Apart from the usual questions of "how did the lesson go?" and "did the children understand or learn (and feel) what they were supposed to learn (and feel)?", these should be supplemented by other questions such as "how did I feel trying out those new strategies?", "how do I know that the pupils really understood the topic and were not just kept busy?" and "could I have handled (t[illegible]ht) the topic differently?"

Reflection-in-action: This incl[illegible]s questions that are rarely asked while making quick decisions: "what am I doing?", "why am I doing it like this?", "what if ......". It involves uncovering implicit or explicit assumptions while one is teaching. One way of giving oneself time to reflect-in-action in class is to respond to a student's question with another question. This gets the student to say more, gives the teacher time to reflect and may even lead to the student reflecting on the situation. It is precisely the development of this kind of systematic thinking strategy for making decisions to improve learning that highlights the role of research endeavour (action-research) in the improvement of the quality of science education.

CONSTRAINTS

There are constraints that will need to be addressed in say primary teachers or secondary school teachers for that matter, assuming the role of researchers albeit informal ones. These are mainly psychological and social:

(i) **Lack of confidence:** A close examination of one's professional performance is personally threatening particularly if one's subject-matter background is inadequate; and the social climate in which teachers work generally offers little support to who might be disposed to face that threat.

(ii) **Examination Pressure**: These may influence teachers to continue to choose traditional teaching and learning activities that aid rote, not meaningful learning.

(iii) **Large Class Sizes**: Tend to influence teachers to maintain a narrow content view of the curriculum for easier classroom and resource management.

(iv) **Unwillingness to Change**: Teachers may be unwilling to change their perceptions of the curriculum objectives and on such things as appropriate teaching and learning activities. Activities in in-service programmes may need to take this into account by providing opportunities for discussion.

SOME STRATEGIES TO HELP INVOLVE SCIENCE TEACHERS IN ACTION-RESEARCH IN THE CLASSROOM

These are:

1. **part of the pre-service education** programme being a teaching practice of say one term. In this time the student should undertake curriculum projects based on their classroom experience. Such projects would aim to develop the science curriculum on the basis of the classroom/cultural context.

2. **in-service workshops** to help groups of teachers work together to find out what ideas and understanding the pupils are bringing to their science lessons about a series of topics particularly those perceived difficult to teach, with access to all the necessary published resources. They would then use the information to create a teaching resource within the curriculum specifications.

3. **pre-service/in-service workshops** on the different perceptions and classroom interpretations of the objectives of the official science curriculum. Activities need to focus on the <u>reality</u> of the classroom, for example, the pupils understandings and constructions of scientific ideas and skills, the nature of science and the usefulness of science.

4. **including technology in the science curriculum.** This not only widens the content of the curriculum but also helps teachers reflect on what science curriculum means to them in their cultural context. This is the issue of (cultural) relevance. Ways to assist teachers to include technology in the science curriculum include:

- encouraging contact between local crafts people (technologists) and teachers so that crafts people can explain the critical aspects of a particular technology;

- in-service workshops which encourage teachers to identify real life problems in the students' own lives and environment. Science and technology can help solve these personal and societal problems.

- as a part of pre-service education, teachers being sent to factories, local fabrication workshops, etc., to look for technologies and related scientific knowledge;

- provision of resource materials, including published texts to illustrate different technologies and the way that science is used to solve a human problem;

- work experiences where teachers and students have experience in a work situation to raise awareness of the uses of science learning in solving real problems. (In this approach technologies are ways to solve problems that are based on scientific knowledge and skills).

To conclude, in considering ways of bridging school science and technology in the context of classroom practice, teachers should be encouraged to look at such issues as how to determine what science and technology is appropriate for their students, the purposes of science and technology education and the appropriate teaching and learning strategies.

REFERENCES

Ajayi, K. (1982) *Attitudes of Teachers and School Administrators to Educational Research in Nigeria.* Paper presented at the Conference on "Priorities in Educational Research", organised by the International Centre for Educational Evaluation (ICEE). Institute of Education, University of Ibadan, 6 - 10 Sept.

Bajah, S. T. (1988) *Science Education at the Classroom. The Challenge of our Time.* Science and Technology Education and the Quality of Life. Kert. Riquarts, ed. Vol. 1.

Begg, A. (1992) *Professional Development: Designing Programmes for High School Mathematics Teachers.* Centre for Science and Mathematics Education Research, University of Waikato, New Zealand

Federal Ministry of Education *Core Curriculum for Primary Science.* Lagos, Nigeria

Frazer, M. J. (1977) *Making Chemical Education Research Useful.* A Report of a symposium: Research for the Classroom and Beyond. University of Loughborough, pp. 80-83.

Fullan, M. & Pomfret, A. (1977) *Research on Curriculum and Instruction Implementation.* Review of Educational research 47 (2) pp. 335-397.

Gounder, T. N. (1992) *Managing Curriculum in the Classroom.* Pacific Curriculum Network, Vol. 1, No. 1, pp. 20-21

IDRC (1976) *Education Research Priorities: A Collective View Ottawa*

Okeke, E. & Inomesia, E. (1986) *Primary Science Teachers' Perceptions of the Teaching of Primary Science.* Journal of the Science Teachers' Association of Nigeria. (JSTAN), Vol. 25, No. 1, pp. 57-66.

Onwu, G. O. (1989) *Problems of Teaching Primary Science.* A paper presented at the National Workshop on Primary Science Education. The Process Skills of Primary Science. University of Ibadan, Dept of Teacher Education. 26 Nov. - 2 Dec.

Onwu, G. O. (1992) *Conducive Classroom Environment for Science, Technology and Mathematics Education, Implications for the Learner.* A lead paper presented at the Science Teacher Association of Nigeria (STAN) 33rd Annual Conference, Enugu, 17 - 22 August.

Stenhouse, L. (1975) *An Introduction to Curriculum Research and Development.* Heinneman Education Books, London.

UNESCO - APEID (1989) *Science for All: Supporting Teacher Change.* Report of a Regional Workshop on Approaches to Teaching and Learning Science For All. Unesco Principal Regional Office for Asia and Pacific. Thailand.

Yoloye, E. A. & Flechsig (1980) *Paradigms of Educational research in Africa,* Educational research for Development. Bonu D. S. E. pp. 21-40.

SCIENCE CAMPS FOR CHILDREN: A Model for Curriculum Renewal and Change

Shaaban S. Mohammed

INTRODUCTION

School science provides a useful knowledge base only if it primarily develops the problem solving skills of young boys and girls. Teaching science through investigation, research activities and problem solving and by linking these with a focus on the local environment achieves a better understanding of science as opposed to rote learning of scientific facts and theories for examinations after which learning ends.

For example, we expect school leavers who study the use of measuring instruments to be able to select which one to use; to be able to judge the expected degree of accuracy for a specific situation; and to be able to design an appropriate tool if one is lacking. Too often in practical examinations, pupils show that they cannot use even rulers properly. Other examples abound.

The claim that science teaching in Africa has become too "theoretical" and not "practical" enough has been made repeatedly. This debate conceals a more basic issue, namely that what is called "theoretical" has nothing to do with thoughts and actions of purposeful people, actively theorising about their world. What is introduced in the name of "practicality" too often consists in teaching rigid procedures in a way that permits only one, "right" answer. Such "theory" and "practice" are neither part of science or technology, nor of the work of scientists and technologists. Science education of this kind is just not enough, given the challenges that the peoples of the world, and especially of Africa, currently face.

Woolnough and Allsop (1985, p 16) argue:

> "... the pupils should perform experiments with their own hands, and second these experiments should not be the mere confirmation of something previously learned on authority, but the means of elucidating something previously unknown (to them).

Science teaching must divorce itself from the erroneous view of science that is best presented by the teacher (and the syllabus) as the sole owner of knowledge where he or she talks pupils through the lesson. Science teaching must shift more to an inquiry-based approach to teaching.

Science camps for children can provide opportunities, not only for children to work in ways more close to those of the scientist, but also for those responsible for running the camps to work in a similar fashion. Within the protected environment of the camp, resource staff can better find out how the educational system is working and how the energy and commitment for change and improvement can be created. Such camp learning is made in a way that the camp philosophy promulgates, namely by active inquiry and by learning from so-called mistakes. Camp resource staff, however sceptical, can never quite be the same after they have witnessed the excitement and competence of children as they use theory and practise as scientists do to solve problems that have captured them. Thus science camps can become the consciousness of the educational system at work to transform itself. They can become a locus for infection and organic representation of the system. Camps can be a place where changes from chalk and talk teaching can be made and inquiry and learning introduced.

Treneman (1967) and Denny (1986) had this to say about the effectiveness of lecture methods to teach facts, the most simple level of knowledge:

> "In a thirty minute talk only 25% of the material heard in the first fifteen minutes could be recalled by adults, even under ideal conditions."

THE ZANZIBAR SCIENCE CAMPS

The Zanzibar Science Camp Project began in 1988. It was established by the Ministry of Education, Zanzibar, with collaboration of the University of Dar-es-Salaam in an attempt to solve problems of science education in the islands. The project would not have been possible without the enthusiastic support of Professor M Bilal, formerly Dean of Sciences at the University and currently Principal Secretary of Science, Technology and Higher Education, and Professor Bob Lange of Brandeis University, Waltham, Massachussetts, USA.

Project objectives are to:

i. motivate students and teachers to appreciate science;

ii. equip teachers with better approaches to teaching science;

iii. formulate better school science curriculum and support material bearing in mind students' cultural and physical environment;

iv. bridge the gap between school and the community;

v. establish effective working relationships between the scientific and educational communities as well as between different departments of the Ministry of Education;

vi. provide a model for curriculum change that involves participants at all levels in the system, thus promoting a sense of ownership, commitment to change, and development of skills needed to promote inquiry-based learning.

Zanzibar has a typical syllabus and examination driven educational system. The usual comments can be made about its emphasis on "theory" and lack of "practicality". The Zanzibar Camp Project provides participants with an opportunity to develop an inquiry-based learning system that it hopes will be more interesting and empowering to the generation that will be called upon to solve the problems of the next century.

The project is intentionally a locus for problem solving. It is complex enough to have every problem the educational system as a whole has. It is an organic representation of the system, populated by people working within the system and provides shelter and safety for experimentation and criticism. The project provides repeated opportunities for participants to express dissatisfaction, to see how much better the system could be, and to work practically to make it work better in camps. The camp is not dominated by any imposed structure, rules or traditions and is an arena that permits no trivial arguments against change. The project is itself a constant reminder that trivial arguments against change should have no place in a wider system striving to put education truly at the use of the people.

The Zanzibar Science Camp project has evolved from its original conception in 1988 of providing a few secondary school students with an exciting three week experience of enquiry based science, and supporting mathematics and language learning. Key milestones in the project's development are:

1989 *Inclusion of camper/teachers from each participating school.

*Distribution of kits of supplementary equipment to participating schools;

*Instituting a formal camp Task Force.

1990 *Science festivals held by participating schools for the local community.

*A school follow-up programme by camp resource staff.

*An environmental education programme introduced and involvement of scientists from the National Institute of Marine Sciences and the Commission of Land and the Environment.

*A computer studies programme introduced.

*An emphasis on attracting female camper/students and resource persons.

1991 *Visit to Mbeya on the mainland to explore possibilities for replication of the project.

*Instituting a Camp Organising Committee.

*Appointment of a full-time project coordinator by the Ministry of Education in the Department of Higher Education, Science and Technology.

*Representatives from Mbeya at the December camp.

*A research seminar concurrent with the December camp.

*Establishment of a science teachers' resource centre in Zanzibar town, with equipment and full-time staff.

*A seminar organised concurrently with the December camp to identify research implications of the project.

1992 *A two-week staff development workshop.

*A much stronger project focus on enquiry science.

*A formal evaluation programme introduced.

*Increased commitment to and planning for implementation of enquiry based, interactive science learning.

All secondary schools in Zanzibar have now attended at least one camp session. In 1993, the project will focus more strongly on expanded resource staff development of teaching/learning material; models for supporting practising teachers; an intensified pre-service education element; and an environmental education and action programme that links researches with the community; as well as primary teacher education.

SITUATIONAL ANALYSIS

Most African countries have a rich environment that abounds with phenomena for promoting inquiry learning, particularly when compared with the urban deserts of inner-city schools in industrialised countries. It is with phenomena, not facts, concepts or even processes that inquiry begins. The school compound and nearby bush are homes for plants with their leaves, flowers, seeds, fruits physiologies and ecologies. Pupils' investigations can be as simple as using plant pigments to make dyes and paints, ranging to the complexities of acids and bases, or the necessary conditions for sensitive plants to close their leaves. (In the 1970s, a class of kindergarten children in Sierra Leone, made this discovery only a few months after it had been confirmed by research biologists). Often pupils do not require the elaborate chemicals, supposedly stocked by secondary school laboratories and the shortage of which is used frequently by teachers to stick to lecture methods of teaching. Familiar material such as flowers, ashes, citrus fruits and so on, often provide a better alternative.

PUPILS' EXPERIENCE

Pupils are themselves an important learning resource for teachers as well as a useful teaching resource. Only if teachers' understand pupils' conceptual view of the word can they hope to bridge those understandings with those of science and scientists. And often, pupils are more effective in helping their peers make the bridge through discussion and cooperation in planning and implementing investigations.

Children bring their own world view to the science classroom, often as a result of their knowledge of the scientific element of the culture of their immediate community.

For example, children have ideas about air. They know it as wind that raises dust, moves tree leaves and can, on occasion, cause great damage. They know air as something that, when deprived of it, animals die, and as something fires need to burn strongly.

Children know that smoke rises and footballs become harder near a fire. Children may have investigated attributes of air as they play with plastic bags, football bladders, paper airplanes and propellers, parachutes and kites. Children can be asked to use their theoretical knowledge, gained from their cultural, and increasingly, school background, together with their practical knowledge gained from play, to solve problems that intrigue them. One such problem would be to investigate the water rise when a closed container is placed over a burning candle standing in a dish of water. By using their own conceptual frameworks to investigate this problem, children develop a better understanding of scientists' understanding, than if they are given a lecture together with the traditional, erroneously explained standard demonstration.

Similarly children in Africa have understandings of many aspects of science and technology and are probably closer to the phenomena than children in industrial countries who frequently experience them as black-boxes or only at second hand through print, film or television. Children in Africa frequently are also closer to scientific and technological problem solving processes and principles than their counterparts elsewhere, as they work with adults farming, caring for livestock, making and repairing tools, traps and weapons.

However, traditional science teaching methods used in Africa ignore children's culture, despite rhetoric about the importance of our cultural heritage. The situation in our schools, and current constructivist theories of learning demand a change to more inquiry based ways of teaching.

SCIENCE CAMPS: THE IMPLICATIONS FOR LEARNING

Participants in the Zanzibar Camp Project have become convinced of the potential that science camps have for implementing change to the benefit of the system and competencies of participating individuals.

Science camps are very effective at generating interest, motivation and commitment. Pupils' delight and excitement are palpable when they are encouraged to investigate familiar phenomena. So too is their boredom, dullness and lack of competence when exploration of their personal interests is replaced by teacher led demonstrations. As one marine research scientist in Zanzibar said after a particularly successful class during the 1992 science camp, "The problem with us teachers is that we must learn to control ourselves. I had no idea that our children were so bright. They were discussing issues in a way that I thought was possible only by scientists and policy makers".

Camps must be designed in ways that permit pupils to investigate, design and construct things that interest them, - and finding out what does interest pupils and in engaging them is in itself a major camp investigation. Children's ideas, like our own when first engaging in an unfamiliar problem, may start simply. But they can develop into work of significant scientific value. The camp environment must accommodate this evolution and work with the richness of children's ideas. Eleanor Duckworth of Harvard once said, that science teaching/learning should be the having of wonderful ideas.

It is pointless to divorce school learning from children's lives outside of school. Any careful observer can walk down urban streets or through a village and see children busily involved with a number of practical activities.

> "They (children) focus on things I would never dream of looking at."
>
> In Osborne and Freyberg (1990).

Camps are concerned with a more focussed attention to learning through such "hands-on" and "minds-on" learning.

Science camps can be used to broaden children's experience by purposeful visits to places such as ponds, farms, the blacksmith or the local market. These too provide rich sources for science learning that are not usually exploited by our schools. Opportunities to study the sky with clouds, the moon and other heavenly bodies are also not usually provided at school. Children are encouraged to do so at camps, making careful observations, models and predictions. Our experience in Zanzibar has been that children will spend many hours of their free time doing so. They experience science as an active search for meaning that does not necessarily need laboratory materials and standard textbook.

Developmental psychologists such as Piaget claim that children, indeed adults, need concrete experience of concepts before these concepts can be fully understood. These concrete experiences can be provided during camps. Children can see, feel and use materials in a way that forces them to accommodate their conceptual frameworks and understanding to explain new phenomena.

SCIENCE CAMPS AS A METAPHOR FOR CHANGE

In Zanzibar, we have grown to see that the real value of science camps is not so much in providing children with an exciting learning experience, but in being a research laboratory for all participants, especially the camp resource staff. Camps provide an opportunity to learn more about learning, both children's and our own, - often it emerges as we plan inquiry-based learning for children that we do not know as much about the subject matter as we thought. Camps provide an opportunity to experiment with and compare different methods of teaching. Camps provide a sheltered background for scientists, teachers and science educators with varying experience, qualifications and starting points to share ideas which can always be resolved by using children as the laboratory. Resource staff have the opportunity and luxury of being able to engage in diagnostic teaching to find out more about how children think. They can experiment with ways to engage all pupils in effective learning, rather than only the usual few high achievers.

> "The most recent developments suggest that improving learning outcomes requires not only the opening of the classroom door to study social interactions, but also requires an insight into individual cognitive processes."
>
> Driver (1985)

As important as providing a laboratory for learning about learning, camps provide an opportunity for resource staff and teachers to express their changing and developing value systems and to strengthen their commitment to inquiry-based teaching/learning through dialogue. They are able to practice new roles as researchers, innovators, motivators, facilitators, diagnosticians and experimenters. In short, whatever the role of resource staff in their places of work, at camps they become used to viewing these roles in a different light that raises their professionalism and commitment to change.

To summarise, science camps provide an opportunity to transform science teaching and of energising individuals within the system to do so.

REFERENCES

Denny M (1986) *Science Practicals: What do Pupils think?* European Journal of Science Education: 8, 4, 325 - 336.

Driver R (1985) *Changing Perspectives on Science Lessons* in British Journal of Educational Psychology. Monograph series No. 2, Scottish Academic Press.

Matyas M. L (1985) *Obstacles and Constraints on Women in Science: Preparation and Participation in the Scientific Community* in Kahle, J. B. (ed) Women in Science. The Falmer Press. (pp 77 - 101).

Roger Osborne and Peter Freyberg (1990) *Learning in Science.* Heinemann.

Woolnough, B and Allsop T. (1985) *Practical Work in Science.* Cambridge University Press.

PROJECT 2000+: DECLARATION

We, participants in the project 2000+ Forum, meeting at Unesco, Paris, France, from 5 - 10 July 1993:

1. Recalling the World Declaration on Education for All, in particular its recognition that 'sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development' and, further recalling recent world-wide expressions of concern for the environment and for the quality of human life, especially those contained in Agenda 21, the output of the United Nations Conference on Environment and Development, Rio de Janeiro, 3 - 14 June 1992;

2. Believing that scientific literacy and technological literacy are essential for achieving responsible and sustainable development;

3. Declare our full commitment to the promotion of science and technology education for all keeping with the World Declaration on Education for All, and our readiness to contribute through Project 2000+ to the concerted action set out in the Framework for Action to Meet Basic Learning Needs;

4. Call on governments, industry, public and private sector interests, and education and other authorities in all countries to:

   a) review critically existing provisions for science and technology education at all levels and in all settings with the aim of giving appropriate attention to development and maintenance of learning programmes responsive to the needs of individuals and communities;

   b) assign priority to the development and introduction of programmes leading to scientific literacy and technological literacy for all with the aim of achieving responsible and sustainable development;

   c) take such steps as may be necessary to ensure equity of access for everybody to science and technology education, notably for women and girls, young children and other under-represented groups;

   d) develop appropriate in-school and out-of-school opportunities, programmes, curricula and assessment procedures for science and technology education responding to the human needs of a scientific and technological society;

   e) ensure and support appropriate pre-service and continuing in-service provisions for those responsible for all forms of science and technology education;

f) encourage and support evaluation, research and development in science and technology education in both formal and non-formal sectors; and to this end:

g) establish and support task forces involving partnership with public and private educational bodies and councils; these might include universities and other institutions of higher and further education, research institutions, libraries, interactive science centres, environmental areas and nature reserves as well as public and private bodies active in the fields of agriculture, natural resources, environment, health, industry, commerce, and the media, and also organizations and individuals specially concerned with science and technology education;

h) recognize the central role of teachers in achieving scientific literacy and technological literacy for everybody, and enhance the status of careers in science and technology education at all levels;

i) recognize the capital role of institutions of non-formal education, such as museums and scientific centres, of the media (radio, television and the press) and all other out-of-school channels for communicating knowledge of science and technology, in fostering scientific and technological literacy for all; and

develop activities designed to set science and its application in a wider social and cultural environment;

j) ensure that adequate resources are available to achieve these aims;

5. Urge United Nations Agencies and other inter-governmental organizations to work together to initiate and support programmes which will advance the ability of countries and of populations to shape their own future in a scientific and technological society and which will increase the capacity of countries for designing, planning and implementing scientific literacy and technological literacy programmes;

6. Urge non-governmental organizations active in fields of science and technology education, as well as the social sciences, and professional associations of teachers and educators and educational organizations at all levels to:

enter into partnership with, and make their knowledge and experience available to, United Nations and other inter-governmental bodies as well as establish innovative programmes in a common effort to achieve the goal of scientific literacy and technological literacy for all; and

participate in national, regional and international programmes for the enhancement of scientific literacy and technological literacy for the improvement of the quality of life in all societies and for the achievement of sustainable development;

7. Recommend that UNESCO makes provision, within its Medium Term Plan (1996-2001) in the field of education, and in the context of Project 2000+, for an international programme to develop co-operation among all countries in the field of science and technology education, with particular reference to the promotion of scientific literacy and technological literacy for all:

This programme, conducted in partnership with the relevant and competent governmental and non-governmental organizations and agencies, should focus on regional and subregional co-operation and on strengthening networks for exchange of ideas, information, human and material resources for science and technology education, and actively seek to promote world-wide:

a) understanding of the nature of, and the need for, scientific literacy and technological literacy in relation to local culture and values and to the social and economic needs and aspirations of each country and its peoples, and also in accord both with the general aims of education for the all-round development of human personality and with human rights and basic freedoms;

b) identification of those issues concerning the applications of science and technology which are of special importance for personal, local and national development and their embodiment and educational programmes;

c) establishment of teaching and learning environments as well as supporting structures conducive to the achievement of scientific literacy and technological literacy for all;

d) formulation of guidelines for the preparation and continuous professional development of science and technology educators coupled with assistance to countries in giving effect to them;

e) development of effective communication, both verbal and visual, assessment strategies and evaluation programmes designed to enhance general levels of scientific literacy and technological literacy;

f) support for the non-formal and informal sector in its own right and support development strategies which will help to stimulate and maintain lifelong scientific literacy and technological literacy;

8. Recommend that by the year 2001 there should be in place appropriate structures and activities to foster scientific literacy and technological for all, in all countries.

APPENDIX I

WORKSHOP PROGRAMME - 2 10 JUNE, 1993

Wednesday 2 June 19937.

Chairman	-	Prof. P. N. Lassa (FMAN), Executive Secretary, NCCE
11.30 am - 1.30 pm	-	Opening Plenary Session - Setting the Pace by Prof. S. T. Bajah, FSTAN
1.30 pm - 2.30 pm	-	Lunch Break
2.30 pm - 3. 45 pm	-	Plenary Session Continues
3.45 am - 4.00 pm	-	Tea break
4.00 pm - 6.00 pm	-	Discussions

Thursday 3 June 1993

Chairman	-	Mike Savage, Rockefeller Foundation
9.00 am - 11.00 am	-	2nd Plenary Session
		Paper Presentations
		(i) Bryan Wilson (ii) H. Gonthi (iii) M. Shaaban
11.00 am - 11.15 am	-	Coffee break
Chairman	-	Prof S. T. Bajah, FSTAN, Commonwealth Secretariat
11.15 am - 1.30 pm	-	Paper presentation continues
		(iv) G. O. N. Onwu (v) Dr J Anamuah-Mensah (vi) R. Hodzi
1.30 pm - 2.30 pm	-	Lunch

2.30 pm - 3.45 pm	-	Group Work
3.45 pm - 4.00 pm	-	Tea break
4.00 pm - 6.00 pm	-	Discussions and responses to presented papers
Chairman	-	Mike Savage

Friday 4 June 1993

9.00 am - 12.00 pm	-	Group work
12.00 pm - 3.00 pm	-	Break
3.00 pm - 6.00 pm	-	Group work continues

Saturday 5 June 1993

9.00 am - 11.00 am	-	Group work
11.00 am - 11.15 am	-	Coffee break
11.15 am - 1.30 pm	-	Group work continues
1.30 pm - 2.30 pm	-	Lunch
2.30 pm - 4.00 pm	-	Group work continues

Sunday 6 June 1993

Free

Monday 7 June 1993

9.00 am - 10.00 am	-	Trip to Zaria - Depart Kaduna
10.00 am - 10.30 am	-	Coffee/tea break
10.30 am - 1.30 pm	-	Working with students
1.30 pm - 2.30 pm	-	Lunch break
2.30 pm - 4.00 pm	-	Discussion

4.00 pm - 6.00 pm	-	Return to Kaduna - depart Zaria

Tuesday 8 June 1993

9.00 am - 11.00 am	-	Plenary Discussions - Zaria trip
11.00 am - 11.15 am	-	Coffee break
11.15 am - 1.30 pm	-	Plenary discussions continue
1.30 pm - 2.30 pm	-	Lunch
2.30 pm - 3.45 pm	-	Plenary discussions with groups
3.45 pm - 4.00 pm	-	Tea break
4.00 pm - 6.00 pm	-	Video films/discussions

Wednesday 9 June 1993

9.00 am - 11.00 am	-	Group work
11.00 am - 11.15 am	-	Coffee break
11.15 am - 1.30 pm	-	Group work continues
1.30 pm - 2.30 pm	-	Lunch Break
2.30 pm - 3.45 pm	-	Tea break
4.00 pm - 6.00 pm	-	Group work

Thursday 10 June 1993

9.00 am - 11.00 am	-	Group presentations
11.00 am - 11.15 am	-	Coffee break
11.15 am - 1.30 pm	-	Group presentations
1.30 pm - 2.30 pm	-	Lunch break
2.30 pm - 3.45 pm	-	Group presentations continue
3.45 pm - 4.00 pm	-	General review of the workshop

4.00 pm - 6.00 pm - Closing ceremony

Resource Persons

Mr Mike Savage
Dr J Anamuah-Mensah
Dr H. Gonthi
Mr M. Shaaban
Dr. R. Hodzi
Dr G. O. Onwu

Co-ordinators

Prof. P. N. Lassa (FMAN)
Prof. S. T. Bajah, (FSTAN)

Local Organising Committee

Prof. P. N. Lassa (FMAN) - Chairman
Dr. M. A. G. Akale
Mrs R. S. T. Akinwale
Mr S. B. Gbadamosi
Mr. J. W. Gadzama - Secretary

APPENDIX II

CHAIRMAN'S OPENING ADDRESS

By Professor P. N. Lassa (FMAN)
Executive Secretary
National Commission for Colleges of Education

His Excellency, the Executive Governor of Kaduna State, Alhaji Mohammed Dabo Lere,

The Deputy Governor, Mr James Bawa Magaji

The Honourable Secretary for Education and Youth Development, Professor Ben Nwabueze

His Royal Highness, the Emir of Zauzau, Alhaji (Dr) Shehu Idris

The Commonwealth Representative, Professor S. T. Bajah

Representative of the Rockefeller Foundation, Mr Mike Savage

Director of the British Council, Kaduna

Heads of Parastatals

Heads of Units and Divisions

Gentlemen of the Press

Distinguished ladies and gentlemen

It is my pleasure this morning to welcome you all to this important training workshop organised and jointly sponsored by the Commonwealth Secretariat, London and the National Commission for Colleges of Education, Kaduna, Nigeria.

The theme of this training workshop is "Improving the Quality of Science, Technology and Mathematics Education (STME) at the basic level: The Role of Teacher Education in Nigeria". The vision of this workshop starting today, was initiated by the Commonwealth Conference of Education Ministers in Barbados in 1990 and approved by the Commonwealth Heads of Government in Harare in 1991. At these meetings, the Education Programmes Department of the Commonwealth Secretariat was mandated to pursue programmes that would improve the quality of basic education with respect to Science, Technology and Mathematics Education. The primary focus of the mandate is Teacher Education. Little was I surprised when Professor S. T. Bajah first approached me that the National Commission for Colleges of Education should jointly organise and host the regional workshop.

This a Train the Trainer workshop, which has drawn participants from very highly selected institutions that are under the umbrella of the National Commission for Colleges of Education. Only twenty (20) carefully selected colleges have been invited as the target group, that will be able to train fellow academic and professional colleagues in the Colleges of Education for Science, Technology and Mathematics Education (STME). Our aim is to raise the quality of Science, Technology and Mathematics (STME) teachers and products in Africa, behold in the Commonwealth countries. One of the criteria for selecting the participants is an ability to play leadership role in training others. You must therefore, rise to the challenges and opportunities that this workshop provides. I understand that a powerful team of resource people from across the African continent have been assembled to take you through the next ten days of rigorous activities. It is my hope that you will take advantage and make the best use of these opportunities, because the future direction of science, technology and mathematics education depends upon you and what you are able to achieve during this workshop.

You all know that science, technology and mathematics have become critical factors of economic and social development. The advances in science and technology have become the index of development. The perception of this workshop of appropriately placed on teacher. The quality of the teachers depends on the qualification and training of the teacher. On the other hand, the quality of teaching depends on the teaching environment and the attitudes of teachers. The teacher is the key resource to science, technology and mathematics education. Any programme that produces excellence and high achievement is taught by qualified and competent teachers. This workshop expects a lot from you.

The Role of the National Commission for Colleges of Education (NCCE)

The National Commission for Colleges of Education, which came into existence by Decree No. 3 of 1989 is mandated among many other things to lay down minimum standards for all programmes of teacher education, among others.

The authoritative position of the National Commission for Colleges of Education (NCCE) is informed by the vision espoused by the National Policy on Education which articulates that the National Certificate of Education (NCE) will ultimately become the minimum basic qualification for entry into the teaching profession in Nigeria. To meet the aspiration of the National Policy therefore, our Colleges of Education, run programmes in science, technology and mathematics education with a view to producing teaches at the NCE level for the 6-3-3-4 system. The Colleges of Education have intensified their admission efforts in these areas of discipline, more qualified teachers are being recruited and facilities for teaching these subjects are being procured. The National Commission for Colleges of Education (NCCE) also has been making efforts in the improvement of Science, Technology and Mathematics Education (STME). This is why we have recently collaborated work with the British Council in introducing the

Nigeria Integrated Science Teacher Education Project (NISTEP), to help boost our training efforts in Science, Technology and Mathematics Education (STME) in our Colleges of Education. We are looking forward to more of such opportunities.

Mr Chairman, and participants, my Commission is leaving no stone unturned in order to realise our desire to produce more qualified and competent teachers in Science, Technology and Mathematics Education (STME) and other school subjects. This workshop is one of such efforts.

I am grateful to the Commonwealth Secretariat for the special honour done to my Commission - the National Commission for Colleges of Education to jointly organise and host this first National-Regional Training Workshop. I am particularly grateful to my long standing friend and colleague Prof. Peter Williams, Director and Professor S. T. Bajah FSTAN, the Chief Project Officer in the Education Programme of the Commonwealth Secretariat, London who championed the cause of this workshop. I wish to thank the Rockefeller Foundation Nairobi, Kenya for sponsoring the International Consultants to this Workshop. I thank you very much for this patronage.

May I also graciously thank the authorities of the Federal Ministry of Education and Youth Development, the Kaduna State Ministry of Education, the National Teachers' Institute, the National Educational Technology Centre and a host of others for their efforts in organising this Workshop.

To our august visitors, the international consultants, I wish you a very pleasant stay in Kaduna, Nigeria. I urge you to avail yourselves of the opportunities to see a little bit of this vast and great country. To the other participants also, I wish and hope that the exposure in this workshop will promote professional and academic cross fertilization of minds, and that at the end you would have met the goals and objectives of the organisers of the workshop and to the utmost satisfaction of your sponsors.

Thank you.

APPENDIX III

GOODWILL MESSAGE

From Mr Peter Williams
Director
Education Programme
Commonwealth Secretariat
London

Your Excellencies

All Other Protocols observed

Distinguished Guests, Ladies and Gentlemen

After so many uncertainties and postponements, I am delighted that this workshop has at last come to fruition. I am particularly delighted that the Rockefeller Foundation is joining hands with us to support this workshop. I want to express our profound gratitude to the National Commission for Colleges of Education (NCCE) for providing a home for a workshop which I am convinced is as important to you as it is to us.

Science, Technology and Mathematics are key areas of concern in the education of children who will, face the twenty first century. Our whole life pattern is even now gradually being affected by STM and will be more so in the twenty-first century. The approach which we at the Commonwealth Secretariat have adopted is guided by the mandate handed down to our programme at the Eleventh Commonwealth Conference of Ministers of Education held in Barbados in 1991. At that conference, the need to improve the quality of basic education was emphasised and to achieve that, the role of Higher Education was stressed. If teachers who teach science, technology and mathematics at the basic level are well trained or should I say well educated, then there would to a large extent be some assurance that learners will be exposed to challenging STM programmes. And those who prepare the STM teachers in higher institutions must themselves be aware of new strategies of communicating science, technology and mathematics to children. Science I am told is best learnt by experiencing it, and as one of your keynote speakers stressed in his paper, you must practice what you preach.

Here at the Secretariat, we have shown special interest in STME. For years back, we have been involved, in collaboration with UNESCO, in the "Process Approach" to teaching science. After several workshops in that area, we now have a bank of information which we have been sharing with Commonwealth countries. The video film, "Righting the Imbalance", which we hope you can watch before this workshop ends presents our effort in enhancing the participation of girls and women into science.

This two-week workshop in Kaduna is therefore a unique opportunity for all involved to exchange experiences, dialogue on new ideas and then come up with materials that will be of use to STM teachers throughout the Commonwealth. The goal of this workshop, I am reliably informed, is to produce draft monographs in key areas in STM education. I do want to wish you a very challenging period and look forward to the outcome.

Let me at this point also remind you of the approach, which was underscored at the planning meeting in Hertford, England. There it was stated that the CASCADE STRATEGY will be adopted. The cascade strategy involves key teachers (like you) who, having been exposed to a training programme (such as you will be exposed to in the coming weeks), will go back and do likewise, i.e., organise similar in-service programmes for their colleagues either in the same school or under the same educational administration. In other words, the cascade strategy has an in-built MULTIPLIER EFFECT. You cannot therefore adopt a passive stance during this workshop.

In your folder, you will find a number of print materials from our Education Programme. These materials have been selected and given to you gratis to enable you to have an insight into our work. In addition to the print materials, we have made available to you our latest catalogue of available publications. Please study these and do get in touch with us if you find any useful material among our list.

Distinguished Guests, Ladies and Gentlemen, I want to wish the participants a very busy but fruitful workshop. I am constantly reminded that there is a great deal of difference between a TALKSHOP and a WORKSHOP. I am convinced that you will discern the difference in the next few days. I want to conclude by thanking the Executive Secretary of NCCE, Professor Peter Lassa for his letter and the very kind things he had to say about our brief but memorable interaction at the London University Institute of Education. The joy is mine to know that you are today shouldering a gigantic programme of not only formulating policies but also prosecuting projects that will make teachers truly professional. I wish you all a very fruitful workshop and to our Moslem friends BARKA DA SALLAH.

Peter Williams
Director
Human Resource Development Group
Commonwealth Secretariat

APPENDIX IV

LIST OF PARTICIPANTS

1. Mrs Felicia O. Eule
Federal College of Education
Pankshin

2. Dr O. O. Bello
Osun State College of Education
Illa-Orangun

3. Mr Mukaila Alani Sotayo
Federal College of Education
Abeokuta

4. Mr Tamuno S. Wilcox
Niger State College of Education
Minna

5. Dr R. E. Nwokedi
Alvan Ikoku College of Education
Owerri

6. Mr Ahmed A Hassan
Federal College of Education
Kontagora

7. Mr Shola B Fagbemi
Federal College of Education
Potiskum

8. Mr Sunday N. Ikwuagwu
Federal College of Education
Akoka-Lagos

9. Mr Samuel M. Mashok
Federal College of Education
Obudu

10. Mr Ibrahim Jubril
Federal College of Education
Bichi

11. Dr (Mrs) Ibiyinka Ogunlade
Adeyemi College of Education
Ondo

12. Mr A. A. Olawale
Federal College of Education
Okene

13. Dr Joel Biebuma
Federal College of Education
Omoku

14. Mr Ibrahim R. Ishaku
Federal College of Education
Zaria

15. Mr Kenneth O. Imarhiagbe
Federal College of Education
Asaba

16. Dr L O Oloke
Federal College of Education
P. M. B. 3045
Kano

17. Mr Mohammed Sani Bichi
Federal College of Education
Gusau

18. Dr M. A. G. Akale
National Commission for Colleges of Education
Kaduna

19. Mr S. B. Gbadamosi
National Commission for Colleges of Education
Kaduna

20 Mrs R. S. T. Akinwale
National Commission for Colleges of Education
Kaduna

21. Mr Joshua W. Gadzama
National Commission for Colleges of Education
Kaduna

22. Mr Alex Maiyanga
National Commission for Colleges of Education
Kaduna

23. Mr A. M. Yuguda
Federal Ministry of Education and Youth Development
(Special Programme Unit)
Kaduna

24. Mrs O. A. Orugun
Federal Ministry of Education and Youth Development
(Special Programme Unit)
Kaduna

25. Mr Pius Osayande Osaghae
Federal Ministry of Education and Youth Development
(Special Programme Unit)
Kaduna

26. Mr J. O. Toluju
Federal Ministry of Education and Youth Development
(Special Programme Unit)
Kaduna

27. Mr Godwin Uche Onah
National Technology Centre
Kaduna

28. Mr M. T. Temi
National Technology Centre
Kaduna

29. Mrs F. A. Adegun
National Technology Centre
Kaduna

30. Mrs Christie Mima Sidi
National Technology Centre
Kaduna

31. Mr M. L. Esenyi
National Technology Centre
Kaduna

32. Mrs A. N. Muoka
National Technology Centre
Kaduna

33. Mrs Mercy Eric
National Technology Centre
Kaduna

34. Mrs C. O. Okoli
National Technology Centre
Kaduna

35. Mrs Ngozi C. Nwokedi
National Technology Centre
Kaduna

36. Mrs Pet Monu
National Technology Centre
Kaduna

RESOURCE PERSONS

1. Dr J Anamuah-Mensah
Department of Science Education
University of Cape Coast
Ghana

2. Mr H. F. Gonthi
Malawi Institute of Education
Domasi
Malawi

3. Dr R. A. Hodzi
Department of Science and
Mathematics Education
University of Zimbabwe
Harare
Zimbabwe

4. Mr S. S. Mohammed
Educational Research and Curriculum
Development
Pemba-Zanzibar
Tanzania

5. Dr G. O. M. Onwu
Department of Teacher Education
University of Ibadan
Nigeria

6. Mr Mike Savage
African Forum for Children's Literacy in
Science and Technology
Nairobi
Kenya

7. Professor S. T. Bajah
Commonwealth Secretariat
Marlborough House
Pall Mall
London SW1Y 5HX, UK

8. Professor P. N. Lassa
National Commission for Colleges of
Education
6A Ahmadu Bello Way
Ali Aklilu House, P M B 2341
Kaduna, Nigeria

APPENDIX V

EVALUATION OF THE WORKSHOP BY PARTICIPANTS

1. Twenty participants were originally invited from twenty colleges of education out of fifty-eight colleges of education in Nigeria, but seventeen (17) participants actually turned up. However, sixteen (16) additional participants were registered because of the desire of their organisations to have them in attendance. Out of the fifteen (15), eleven (11) were from the National Educational Technology Centre, Kaduna, while the remaining four were from the Federal Ministry of Education and Youth Development, Special Programmes Unit, Kaduna.

2. In order to improve the conduct of similar workshops in the future, participants were asked to complete an evaluation questionnaire. The questionnaire form is attached to an appendix of this annex, which summarises the responses by the participants.

   At the end of the workshop, 26 participants actually returned their forms.

USEFULNESS OF THE ACTIVITIES OF THE WORKSHOP

Q1. How useful did you find the different activities of the workshop?

(a) ***Plenary Session:- Setting the Pace***

Thirty-five percent of the participants felt that the activities at the plenary session were very useful, fifty-four percent felt that the activities were useful, while eleven percent were of the view that the activities were fairly useful. The implication of the above is that the activities at the plenary have beneficial to the participants.

(b) ***Paper Presentation***:-

Thirty-one percent of the participants were of the view that the presentations were very useful, fifty-four percent felt that it was useful fifteen agreed that the presentation of paper was fairly useful. Nobody felt that the presentation was less useful. In other words, the activities during the paper presentation were generally useful to the participants.

(c) ***Monograph Group Work***:-

Seventy-three percent of the participants felt that the activities during the group work sessions were very useful; twenty-six percent were of the view that the activities were useful while only four percent felt that the activities of the Group-work were fairy useful. This implies that the activities were very useful to the participants.

(d) ***Working With Students - FCE Zaria***:-

Forty-six percent of the participants felt that activities at the FCE, Zaria were very useful, forty-six percent were of the view that the activities were useful, four percent felt that the activities were fairly useful while the remaining four percent felt the activities were a bit useful. The conclusion from this is that the activities at Federal College of Education, Zaria were generally useful.

(e) ***Video Film Session***:-

Nineteen percent felt that the video session was very useful; forty-two percent were of the view that the session was just useful; thirty-one percent were of the opinion that the session was fairly useful; four percent felt that the session was a bit useful while the remaining four percent felt that the video session was less useful. The general opinion is that the video session was useful.

(f) ***Group Presentation***:-

Twenty seven percent of the participants felt that the activities during the group presentation were very useful; fifty-four percent were of the view that the activities were useful while the remaining nineteen percent felt that the activities were fairly useful.

2. (a) About eighty-eight (88) percent of the participants strongly believed in their own contribution towards the achievements of the workshop objectives while the remaining 12 percent simply agreed.

(b) ***Resource Person's Usefulness in the Monograph Groups***

Forty-six percent of the participants felt that the resource persons contribution were very useful in the monograph work while 42 percent were of the view that their (resource person's) contributions were useful while the remaining 12 percent believed that their contribution were fairly useful. The conclusion from this is that the resource persons' contributions were highly useful and beneficial to the participants during the group work.

(c) *Participant's Understanding of CASCADE Model of INSET.*

About 81 percent of the participants felt that they actually understood the CASCADE Model of INSET while the remaining 19 percent felt that their understanding of the model is either fair or a bit fair.

(d) ***Participants' Ability to Play a Leadership Role in the Training of other STME Lectures as a Result of the V. orkshop***

Eighty-two percent of the participants strongly felt that they can play leadership role in STME as a result of the workshop while the remaining eighteen percent are partially sure of the ability in this regard.

3. (a) ***What New Ideas (if any) Did You Learn During the Workshop?***

The new ideas acquired during the workshop as stated by the participants are:

i. Science camps
ii. Inquiry approach to teaching
iii. Interactive teaching
iv. Dialogue teaching
v. Utilization of community materials
vi. Use of computer assessment
vii. Improvisation of OHP
viii. Writing of monographs
ix. CASCADE method

(b) ***What Changes (if any) Would You Seriously Consider Changing in Your Institution's Training Programme?***

The following changes have stated by the participants:

i. INSET programme participation
ii. Adequate research funding
iii. Training the existing staff in the colleges
iv. Encouragement of more group work in teaching
v. Incentives should be given to STME teachers
vi. Forum for all lecturers in colleges to come together to consider team teachers.

4. **What Additional Topic Areas in STME Would You Have Liked the Workshop to Consider?**

The additional topics as suggested by the participants are:

i. Science library/resource room
ii. Use of computer in STME
iii. Micro-teaching organization

5. **General Comments on the Workshop**

Participants expressed their views about the workshop in different ways: Some described the workshop as innovating, educative, rewarding, successful, satisfactory, highly exposing and informative. Others stated that the workshop was nicely conducted and highly rewarding.

In short, majority of the participants shared the view that the workshop was highly successful.

6. **What is it that You Would Have Liked to See Happen in the Workshop that did not happen?**

Participants views vary on this question. However, some of their views are as follows:

- Incorporation of practical demonstration of some of the education theories;

- Computer education;

- Production of Modules/Monographs on different areas of STM;

- Emphasis on Technology.

7. **Any Other General Comments**

According to the majority of the participants, everything about the workshop was perfectly done. The workshop had bee educative, stimulating and refreshing. The workshop objectives were achieved. The participants commended the efforts of the consultants and the National Commission for Colleges of Education staff for a job well done.

Finally majority of the participants called for more of such workshops.

Question 1. TABLE OF ANALYSIS

How Useful did you find the different activities of the Workshop?

	Very Useful (5)	Useful (4)	Fairly Useful (3)	A bit Useful (2)	Less Useful (1)	Total
a	9 *34.61	14 *53.85	3 *11.54	0 *0	0 *0	26
b.	8 *30.77	14 *53.85	4 *15.38	0 *0	0 *0	26
c	19 *73.08	6 *26.08	2 *3.84	0 *0	0 *0	26
d	12 *46.15	12 *46.15	1 *3.84	1 *3.84	0 *0	26
e	5 *19.23	11 *42.31	8 *30.77	1 *3.84	1 *3.84	26
f	7 *26.92	14 *53.85	5 *19.23	0 *0	0 *0	26

Note: * *percentages*
For questions under a - f see questionnaire.

Question 2 ANALYSIS TABLE

	Very Useful (5)	Useful (4)	Fairly Useful (3)	A bit Useful (2)	Less Useful (1)	Total
a	12 *46.15	11 *42.31	2 *7.69	1 *3.84	0 *0	26
b.	12 *46.15	11 *42.31	1 *3.84	2 *7.69	0 *0	26
c	2 *7.69	19 *73.08	5 *19.23	0 *0	0 *0	26
d	10 *38.46	12 *46.15	4 *15.39	0 *0	0 *0	26

Note: * *percentages*
For questions under a -d see questionnaire.