MONOGRAPH 1

The training needs of science and technology teacher educators

1.1 Overview

In most developing countries the provision of a good basic education is a matter of great concern. High quality science and technology education depends on effective and efficient training of teachers. This in turn depends on the quality of the teacher educators. At present, there is little comprehensive information available about the academic and professional qualifications of science and technology teacher educators, or about their responsibilities and training needs. The best intentions for improving teacher education will fail unless attention is paid to improving the quality of science and technology teacher educators.

1.2 Objectives

The objectives of this monograph are to help policy makers and administrators, responsible for the recruitment and training of science and technology teacher educators, by:

- identifying the professional and academic qualifications and training needs of science and technology teacher educators;
- considering ways of improving the qualifications of science and technology teacher educators and of enabling them to keep abreast of developments in their fields.

1.3 Recruitment and training

The recruitment process normally involves some form of advertisement seeking applications, followed by short-listing of candidates against established criteria, and selection based on performance in oral interviews.

The ideal candidate for a science and technology teacher educator post would usually need to meet the following criteria:

- Possession of an appropriate professional qualification, such as BEd or a Post-Graduate Certificate in Education (preferably directed at primary or basic education),

and, ideally, an MEd qualification. Relevant teaching experience at the appropriate level would be a specific advantage. (A candidate with secondary experience would need to show evidence of some clear interest, involvement or willingness to gain direct experience of work at the primary level of science and technology education.) Three to five years of primary teaching experience is the usual basic requirement.

- Academic qualifications indicating a broad basic grounding in science and technology, including, ideally, a first degree in a science-related area or equivalent qualifications in technology. Candidates who lack breadth in their academic qualifications would need to indicate a willingness to remedy such shortcomings within a given time.

- Evidence of involvement with, and active participation (including extra-mural activities) in, a relevant professional organisation, such as the following, would be an advantage:
  – Science Teachers' Association of Nigeria (STAN)
  – Ghana Association of Science Teachers (GAST)
  – Southern Africa Association for the Advancement and Research in Maths and Science Education (SAARMSE)
  – Namibian Association of Science Teachers (NAST).

- Possibly some indication of research interests, or evidence of a capacity for, or commitment to, research in science and technology education through academic, professional or popular writing.

- Reliable testimonials and confidential referees' reports.

At the short-listing stage, due consideration needs to be given to gender equality. In many countries, science and technology education departments in colleges and universities are dominated by men. These countries should make deliberate attempts to identify suitable women candidates. Women science and technology teacher educators not only bring a different perspective to the training of teachers, but can provide teachers with strategies for promoting participation by girls in science and technology.

At interview stage, the extent to which short-listed candidates meet the following criteria can be assessed:

- Positive attitude towards science and technology education, including the gender perspective, and keeping abreast of current developments in science and technology education.

- Potential ability to adapt to, and understand, the contextual needs of the specific institution and the community it serves.

The teaching ability of candidates might be compared by requiring them to present a prepared lesson, lecture or practical class to students. This emphasises that practical teaching ability is as important as paper qualifications and skilful interview technique.

Unless a country is already well supplied with candidates meeting these criteria for science and technology teacher educator posts, appropriate training will need to be provided to make up the short-fall. The selection process involved in recruitment will indicate clearly what the general and individual training needs are and how they might be met through in-service training courses.

1.4 Career paths

Criteria for promotion of science and technology teacher educators, as for other academic staff, usually include:

- A satisfactory period of service – normally two to three years after appointment.
- Evidence of a research interest in science and technology education, through the presentation of a case study or research papers to peers, or through publications.
- Evidence of administrative capability and leadership skills.
- Satisfactory Head of Department's assessment report and recommendation.
- Evidence of involvement, with local and regional science and technology teachers, in ongoing professional support and development, as well as a commitment to professional development of colleagues.

1.5 Academic and professional needs and responsibilities

In order to improve the quality of science and technology education at the basic level we need to meet the academic and professional needs and responsibilities of science and technology teacher educators. The quality of science and technology teachers depends on the availability of

science and technology teacher educators with sufficient grasp of the challenge and complexity of introducing young learners to the basics of these disciplines in a holistic and integrated way.

Currently, there are no courses that specifically train such teacher educators. In the short term, quality In-Service Education and Training (INSET) for science and technology teacher educators will be required. In the long term, a clear route will need to be developed to enable potential science and technology teacher educators to gain the academic and professional qualifications they need. Their **academic** needs may include updating on knowledge of subject matter and content. Their **professional** needs include an understanding of and confidence in the use of subject-specific pedagogical skills, together with an understanding of appropriate methods for science and technology education research.

These specific requirements exist within the wider **context** which will include gender issues, ethical and humanistic issues in science and technology, cultural awareness, communication skills and liberal and African studies. The academic and professional needs interact with one another as well as with the context, as shown in Figure 1.

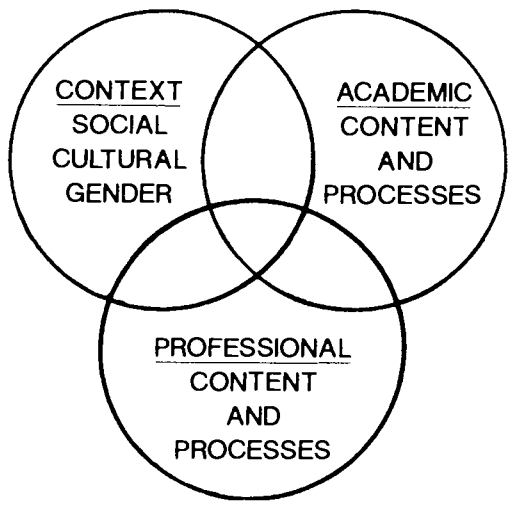

Figure 1: The interactive nature of the areas of training

Table 1 summarises the broad training needs of science and technology teacher educators and indicates where subsequent training might be required for individuals with identified professional or academic shortcomings.

Table 1: Academic and professional needs of science and technology teacher educators

ACADEMIC		PROFESSIONAL		CONTEXT	
Science and technology subject knowledge	Science processes	Education studies	Subject-specific pedagogical skills	Curriculum studies	Manpower development studies
	Observation. Classification. Experimentation etc.	Educational psychology. Philosophy of education. Sociology of education.	Teaching methods. Micro-teaching. Teaching practice.	Science and technology education research. Materials development.	General liberal studies. Cultural/ community awareness. Communication (language skills, etc.)

Science and technology teacher educators will have to develop competence in their trainees across the whole breadth of science (biology, chemistry, physics, earth science) and technology, including coverage of all the areas that the teacher will have to teach. They need to:

- be able to demonstrate the investigative and problem-solving approach to science and technology;
- be able to present examples of open-ended investigations and how to report them scientifically;
- encourage trainee teachers to generate their own investigations and follow them through, so that they in turn learn how to support and encourage their pupils in the same processes at their own levels;
- be able to demonstrate the significance of classroom skills in relation to real-life problems;
- be up-to-date with current learning theory, such as the recognition that different children build up knowledge in different ways.

1.5.1 Academic responsibilities

Science and technology teacher educators usually have the following responsibilities:

- **Teaching.** To organise, implement, and critically evaluate the content of science and technology curricula and appropriate teaching methods.
- **Practice teaching.** To support student teachers in teaching practice (see Monograph 2).
- **Research.** To design, plan, conduct, and publish research.
- **Evaluation.** To carry out continuous review of existing programmes and the diagnostic and formative assessment of students' academic attainment and progress.

- **Record keeping.** To keep accurate records of examination results, nominal rolls, laboratory stock, workshop materials, etc.

It is important for science and technology teacher educators to be academically well prepared and equipped to meet the demands made of them. They should be familiar with the subject matter and content of the curriculum. They should understand how science and technology, their philosophical foundations and sociological aspects, are interrelated. This is important, because problems in science and technology tend to require skills and knowledge that are cross-disciplinary in nature and best handled by team-teaching. Science and technology teacher educators also need to have a basic knowledge of everyday applications of science and technology, their social implications and how the concepts and processes are used in industry and commerce.

Administrators can encourage teacher educators to take up research by:

- making research opportunities available;
- offering grants;
- facilitating attendance at conferences;
- organising in-service training in research methods and report-writing and providing professional support at different levels of research;
- communicating research findings through newsletters or journals.

1.5.2 Professional responsibilities

The science and technology teacher educator needs to possess pedagogical knowledge, both of concepts and procedures, and to able to pass this on to pre-service students and in-service teachers to improve their general effectiveness in the classroom. They therefore need to develop competence in the following areas:

- **Pedagogical skills.** These are the conceptual knowledge and procedural skills needed to enable teacher educators and teachers to bring about effective learning. They include selection and use of appropriate teaching strategies for particular objectives, class sizes, available materials, learning environments, etc. They also include the ability to guide students in reflecting on their teaching and to encourage their involvement in the teaching–learning process.

- **Supervisory, guidance and counselling techniques.** The science and technology teacher educator needs to develop skills in classroom observation, guidance and counselling of students on academic and professional matters, including supervision of teaching practice or during 'micro-teaching' (see 2.6) sessions.

- **Social and psychological considerations.** Understanding the social and psychological characteristics of prospective science and technology teachers and pupils at basic education level, and providing guidance to prospective teachers on how to deal with them. Understanding gender issues in science and technology education and the strategies to deal with them.

- **Curriculum development.** Constructing curriculum materials and teaching–learning aids.

- **Research.** Carrying out 'action research' (see 6.6) and other types of research in education, which can contribute to understanding the needs of the pupil, the classroom and the school in general.

There is currently an imbalance in the practice of these academic and professional responsibilities. Science and technology teacher educators need to put themselves in the place of teachers, attend seminars and spend time actually working in schools. This will make their own teaching much more realistic and effective, because it will be based on real classroom experience.

1.6 Strategies for ongoing professional development

Science and technology teacher educators needs support, throughout their teaching careers, to develop both academically and professionally. In the *Final Report of the International Forum on Scientific and Technological Literacy for All* (UNESCO, 1993), it was stated that such support should include:

- partnerships between the world of production and the community, which would allow teacher educators to be exposed to the latest technology and also increase society's commitment to science and technology teacher education programmes;
- updating appropriate teaching/learning instructional materials, facilities and equipment;
- updating of teaching skills, knowledge of learners and content;
- induction programmes for beginning teacher educators;
- assistance in developing leadership skills;
- salary structures attractive enough to recruit and retain the best teacher educators;
- adequate reward for teacher educators for those activities which are related to maintenance of their continued involvement with teaching as a dynamic profession.

These measures can be realised through:

- in-service education programmes organised by universities, colleges of education, subject associations and employing authorities (i.e. Ministries and Departments of Education);
- formal links, including visits and attachments, with industry;
- teaching at the school level and carrying out action research with science and technology teachers;
- provision of resources by governments, including improved salary conditions;
- joining professional organisations;
- corresponding with other professional science and technology teacher educators.

1.6.1 Types of INSET programmes

In-Service Education and Training (INSET) is essential for updating the knowledge and improving the professional competence of science and technology teacher educators and teachers. At present, there are no regular INSET programmes specifically designed for science and technology teacher educators. Provision should focus on development needs, current issues and policy matters, as well as training and certification needs. The following are suggestions for types of INSET programmes.

Issue-based INSET

- **Workshops.** Hands-on activities designed to cater for specific professional development in terms of knowledge and skills.
- **Seminars.** Discussion – usually of short duration – of academic and/or professional issues and problems. They normally consist of talks or presentations followed by discussion, often in small groups. There should also be opportunity for plenary, summary discussion.

Certification-based INSET

- **Sandwich courses.** These can be organised by colleges of education, universities and polytechnics during long vacations to upgrade science and technology teacher educators professionally. Periods of normal teaching are alternated with short periods of full-time attendance at local colleges. Sandwich courses can be supplemented by distance-learning modules or specific practical projects or tasks (action research). Follow-up field visits by course co-ordinators contribute to the effectiveness of sandwich courses.
- **Study courses.** Science and technology teacher educators are granted full-time study leave in order to attend courses leading to a qualification. Such courses are INSET in the sense that a serving teacher educator breaks service to study. This is a means by

which underqualified teacher educators can obtain qualifications and qualified teacher educators can upgrade qualifications.

- **Distance-learning courses.** Structured learning modules are made available to students through a variety of media. There is minimal contact with tutors, and the student does not need to obtain study leave to be able to participate. Professional elements such as teaching practice are assessed by specially designated local personnel.

Institution-based INSET

- **In-college activities and meetings.** Organised by college departments, these enable science and technology teacher educators to exchange ideas and experiences and thus improve the quality of their teaching.
- **Conferences.** These may be local or international. They usually involve presentations, by science and technology teacher educators, of innovative methods and examples of good practice in schools. They provide teacher educators with the opportunity to update themselves on the latest equipment and published materials for science and technology education. Such conferences are a very valuable resource for sharing problems and new ideas.

School-based INSET

It is important for science and technology teacher educators who have been in a post for some years, to be officially released for a period to update their teaching experience at the level for which they are training students. This gives them a better understanding of the needs, characteristics and aspirations of the teachers and pupils in schools, and encourages the teacher educators to see themselves first and foremost as educators rather than as subject specialists.

Peer-group INSET

Science and technology teacher educators meet together as equals to share their problems and success stories. They can develop learning materials during such meetings. These can be at least as effective as the traditional 'course' led by an 'expert'.

Visits

Science and technology teacher educators should be encouraged to visit industries and other science and technology-based establishments such as science museums to acquaint themselves with the applications of science and technology principles in daily life. Visits may be for a day or involve extended periods of attachment to an establishment.

1.6.2 Content of INSET programmes

INSET programmes for science and technology teacher educators should include consideration of:

- the needs of the community in which the teacher educators are likely to work and of ways of orienting science and technology towards community problems;
- the content and objectives of science and technology education at different levels;
- problem-solving techniques;
- gender issues and how they can be addressed;
- the use and maintenance of science equipment and a laboratory;
- learning science and technology in a second language;
- management, co-ordination and use of resources;
- hands-on activities which integrate science and technology;
- the cultures of scientific and technological enterprises; their values, attitudes, assumptions, organisational structures and limitations.

Table 2: Examples of INSET programmes for science and technology teacher educators

TYPE	ORGANISER	LENGTH	ACTIVITIES	OUTCOME
Issue-based				
Workshop	Professional association, educational agency, private organisation, Ministry of Education, college of education, polytechnic, university	Varies	Lectures, demonstrations, discussions, practicals	Improvement in professional and academic competence
Seminar	As in workshop	1–3 days	Lectures, demonstrations, discussions	As in workshop
Certification-based				
Sandwich courses(vacation courses)	College of education, polytechnic, university	2–10 long vacations of about 10 weeks each	Practicals, lectures, demonstrations	Undergraduate diploma
Study courses	College of education, polytechnic, university	1–2 academic years	Lectures, demonstrations, practicals	Undergraduate diploma
Distance learning	University	1–3 years	Self-instructional modules, with follow-up contact for lectures, demonstrations, discussions	Undergraduate diploma
Institution-based				
In-college activities and meetings	college of education	Usually not more than a day	Discussions, demonstrations	Exchanges of ideas, update of professional and academic knowledge
Conferences	Professional association, educational agency, university	1–5 days	Lectures, demonstrations, discussions, practicals	Exchanges of ideas, update of professional and academic knowledge