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International Council of Associations for Science Education

# Innovations in Science and Technology Education through Science Teacher Associations

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**Abstract**
*One emerging issue highlighted in a UNESCO booklet (Fensham, 2008, p6) is to draw attention to the need for students to receive science education from able science teachers. The booklet emphasizes that quality science learning time, albeit less, is preferable to the damage done by underequipped science teachers. It also draws attention to the important role of science teacher associations, where its members not only have the insights and experience, but also the interest in helping science teacher colleagues. This paper highlights the various contributions possible from Science Teacher Associations (STAs) to the development and delivery of innovative science and technology education in a world that is increasingly driven by the outputs of science and technology. It stresses the key role of such professional bodies in developing teacher ownership, the sharing of experience at a collaborative level and to be guided to take active responsibility for the interpretations of the intended Government curriculum so as to provide innovative science education best suited to students within their school. Any shift away from 'teaching the textbook information', 'teaching to the examination' and towards 'assessment for learning' (formative assessment) will be heavily enhanced by the setting up of multiple professional fora for enhancing the development of teacher's PCK (pedagogical content knowledge).*

***Key words:*** *Association, Curriculum, In-service, Publication, Science, Teachers*

## Introduction

Science contributes to the quality of life in so many areas: health, nutrition, agriculture, transportation, material and energy production, and industrial development. It ensures that the air we breathe, and the water we drink are life sustaining and not vectors of disease and decay. According to Ware (1992), the International Council of Scientific Unions - Committee for the Teaching of Science (ICSU-CTS) summaries the importance of science (and by extension science education) to economic development as follows:

> *Long term sustained growth can be assured only if the money invested in science and technology is matched by the provision of funds for complementary educational programmes directed both to the preparation of scientists and technologists and to the improvement in science literacy of the population as a whole… At all levels from the ubiquitous "man-in-the- street"*

> *to the most influential ministers, there is a tendency to take education for granted. But unless it is supported on the necessary scale, long term development will not be successfully achieved.*

Science and technology have become crucial factors for sustainable development worldwide. Both have contributed immensely to the material progress of nations. It is in fact generally accepted that the adoption of a scientific frame of mind is a prerequisite for development. Associated with this in any country are issues of education which are of considerable importance for economic prosperity. And, in a developing country, issues of science and technology education are even of more particular importance, as it is principally by means of science and technology education that its people can achieve national development (Gift, 1991). It is clear that nations at the forefront of modern development, as we witness the beginning of another century, are those that have invested enormous resources over considerable time in three major areas: first, in the establishment and nurturing of a stable, well-supported science and technology system; second, in the promotion of mission-oriented research in the basic sciences, coupled with a long-term strategy for technology development; and third, in the institution of well-articulated programmes for the education of a large scientifically and technologically literate work force (Brown and Sarenitz, 1991).

Since science holds the key to sustainable development, the corollary is that prominence must be given to science education in schools. That is why in recent years attempts have been made to improve the quality of delivery of science, technology and mathematics education (STME). In the pursuit of this goal, several agencies have played notable roles. In many countries, one such agency is the national science teacher association (STA).

**What are STAs?**

Generally, Science Teacher Associations (STAs) are non-political, non-religious and not-for-profit professional organizations whose goal is to improve teacher effectiveness in science, technology, and in some cases, engineering and mathematics.

**Types of STAs**

There are three types of science teacher associations: local, national, and international. This paper focuses mainly on national STAs. The following is an example:

**Science Teachers Association of Nigeria (STAN)**

Established on 21 June 1957, STAN as a professional association, has the following aims:

- To promote co-operation among science teachers in Nigeria with a view to raising the standard of science education in the country.
- To provide a forum for discussion by science teachers on matters of common interest.
- To help science teachers keep in touch with developments in science and its applications to industry and commerce.
- To popularize science.
- To co-operate with and affiliate to other societies and bodies with related interest.

The major functions of the Association (Silber as cited in King 1991:47***)*** include the following:

- Communications -Journals, conferences, publications.
- Representation - To teachers and government, liaison with other groups and participation in international activities.

- Services - continuing education, employment, low cost equipment and out-of-school activities.
- Leadership - Curriculum development, teacher benefit, guidance on new development in science education.

In fact, in Africa, STAN has tremendous influence on STM education not only in its country but also in foreign nations. Bajah & Yoloye (1981:27) while evaluating *Science Education Programme for Africa* had this to say:

> *A powerful kind of organization that stimulated development in science education in practically all the countries was the association of science teachers. Every one of the countries studied had such an association in one form or another. There were variations in the magnitude of contributions made by these organizations from country to country. Gambia, Liberia and Lesotho report negligible contribution. At the other end the Ghanaian and Nigerian associations have exerted tremendous influence on the training of science teachers, the curriculum, and educational policies. STAN in Nigeria produced its own books in integrated science for the first two years of secondary schools.*

Others (Dienye and Gbamanja, 1990; King, 1991) are in general agreement with the above assertion. According to King, the achievement of STAN in the pursuit of quality education in science in Nigeria is a noteworthy record. This is because STAN has produced curriculum materials and support textbooks which have gone a long way towards the development of STM Education.

STAN is administered by three separate, but mutually supportive organs: the Annual General Meeting, The Governing Council, and the National Executive Board. It has fifteen-subject panels: Agricultural Science, Basic Science, Basic Science and Technology, Biology, Chemistry, Environmental Education, Gender and STEM Education, Home Economics, Information and Communications Technology, Mathematics, Physical and Health Education, Physics, Science-Technology-Society, Teacher Education, and Technology Education. There is a branch in each of the nation's 36 States as well as a Federal Capital Territory branch in Abuja, which also hosts the National Headquarters at The STAN Place. At this time, STAN is the only STA in Africa "with a permanent Secretariat and vehicles, and it's been a leading light in the various attempts to develop an African super-association, its publications, courses and conferences being highly regarded" (Deeson, 1993:1). The African Forum for Children's Literacy in Science and Technology, in the May 1992 edition of its newsletter also describes STAN as a 'successful model'.

Apart from national science teacher associations, there is an umbrella international organisation which has contributed immensely to STEM education. It is to this that we now turn.

**International Council of Associations for Science Education (ICASE)**

ICASE was established in 1973. Its role is to:

- extend and enhance the quality of formal and non-formal science and technology education for all, with particular reference to the children and youth of the world.
- provide and support activities and opportunities that will enhance formal and non-formal science and technology education throughout the world.

- assist and support all members and other organisations throughout the world which are involved in formal and non-formal science and technology education.
- establish and maintain an international communication network for member organisations and their members involved in formal and non-formal science and technology education.
- encourage and support the establishment and development of professional science and technology organisations, especially teacher organisations in all countries.

The Governing body of ICASE is the General Assembly consisting of one delegate from each member Association together with any members of the Executive Committee who are not delegates. The Executive committee consists of the President, a President-elect or an immediate past President, the Secretary, the Treasurer, the Elected representatives from each of the ICASE regions and the chairpersons of ICASE standing committees. ICASE is financed, in part, by annual fees from member associations, institutions, foundations and companies. But because it is *not a foundation* (and is not funded directly by any Foundation), *so it has no means of assisting member associations financially.* Furthermore, ICASE has no permanent Secretariat. Its major contribution is as an umbrella organization, keeping abreast of innovative development around the world and in disseminating information through its monthly newsletter, its journal and on a three - yearly basis, through a World Science and Technology Education Conference.

STAs have made major contributions in Science and Technology Education in a variety of areas. Taking STAN as an example, the following areas point to STA innovations:

**1. Curriculum Development and Renewal**

In Africa, STAN is probably a good example of how a STA can be involved. As long ago as 1968, a request was made to STAN by the West African Examinations Council (WAEC) to make recommendations on the review and improvement of the then GCE 'O' level science syllabuses. A revision was thought necessary due to developments in science education all over the world. Consequently, STAN set up four curriculum development committees, one each in Biology, Chemistry, Physics and Mathematics. The project was funded by the *Ford Foundation* (through the Comparative Education Study and Adaptation Centre (CESAC), *Curriculum Renewal and Educational Development Overseas* (CREDO) through the British Council. Support in the form of curriculum materials was received from UNESCO and from Longman (Nigeria) publishing company.

Later, an additional Committee was set up to take care of integrated science. The publication of Curriculum Development Newsletter No.1 (STAN, 1970a) meant that things could not be the same again in Nigeria with respect to science teaching. In a *Foreword* to the newsletter, the then General Secretary of STAN Rev. P. S. Samuel (STAN 1970a:3) said, inter alia:

> *The need for curriculum Reform in Science Education in Nigeria has been felt by the members of the Association for some time and especially since the great Curriculum Reform movements, such as B.S.C.S., P.S.S.C., Chemstudy and C.B.A. in the United States, the Nuffield Teaching Project in the United Kingdom and the work of Scottish Education Department, began to influence the general education atmosphere everywhere. However, professional associations are seldom strong enough financially or sufficiently strong enough to carry out such important task alone. The Science Teachers Association of Nigeria nevertheless felt that it was time to do something*

> *about the development of a new science teaching curriculum for schools…we hope that this is the beginning of a long and important process in which we invite comments, criticisms and suggestions on the content of our work so that we may improve upon it in future. With this hope and prayer, we present the first fruits of our Curriculum Development work to teachers and other science educators.*

The document proposed that the integrated science course should enable each Nigerian student to:

- be actively involved in the learning process;
- develop the motivation and ability to work and think in an independent fashion;
- recall information and experiences;
- devise schemes for solving problems;
- use and classify given information;
- apply previous knowledge to new situation;
- interpret information showing evidence of judgment and assessment.
- communicate selectively and effectively.
- relate experiences in each subject area to other areas and to live in the society.

This was very innovative thinking as it reflected on learning above and beyond subject matter. Accordingly, the course envisaged that the following skills would be acquired by the student:

- observe carefully and thoroughly;
- report completely and accurately what is observed;
- organise information acquired by the above process;
- generalise on the basis of acquired information;
- predict as a result of these generalizations;
- designing experiments (including controls where necessary) to check these predictions;
- use models to explain phenomena, where appropriate; and
- continue the process of inquiry when new data did not conform to predictions.

The course, initially planned for two years, gave way to a three-year course following the introduction of the 6-3-3-4 system of education in Nigeria. The present science course has modified the spiral system themes adopted under :

- You as a living thing.
- You and your home.
- Living components of the environment.
- Saving your energy.
- Controlling the environment.

According to Otuka (1993), at the inception of the 6-3-3-4 system, the Federal Ministry of Education embarked on streamlining the existing curricula in use in all schools so as to produce a single national curriculum content in each science subject. It is to the credit of STAN that some of its members served as resource persons during the exercise in 1984 and 1985.

The Nigerian Educational Research and Development Council (NERDC) has recently renamed 'Integrated Science' as 'Basic Science' while 'Primary Science' has been renamed 'Basic Science and Technology'.

The work of STAN in curriculum development in Nigeria has been so pervasive that it has usually been regarded as a curriculum development agency. In the words of Ivowi (1993:353):

> *In appraising the performances of the curriculum development agencies (in Nigeria), five such bodies, namely, the Nigerian Educational Research and Development Council, West African Examinations Council, National Teachers Institute, National Commission for Colleges of Education, and the Science Teachers Association of Nigeria have been singled out. STAN, a professional association that has contributed much to curriculum development in Nigeria is here regarded as a curriculum development agency. It is a very typical and foremost example of such professional association in Nigeria.*

Today STAN continues to be involved in curriculum development projects.

**2. Production of Textbooks**

By far the greatest and most remarkable innovation in the area of textbook production by STAs in Africa is by the *Science Teachers Association of Nigeria (STAN).* Following the successful production of an Integrated Science Curriculum by STAN, a panel of authors was constituted to write Integrated Science textbooks for students and teachers. According to STAN (1971b:iv) '*the seminars which preceded the actual writing should be properly recorded and studied as a successful model for achieving an integration of knowledge and methodology*.' It is worth noting that the STAN Integrated Science writing team combined the basic requirement for expertise, with broad geographical representation. A two-year course comprising Pupils' Textbooks, Pupils' workbooks (for practical work) Teachers' Guides was produced. First published in 1971, the books have since been revised and restructured into a three – year course comprising Pupils' Textbooks, Pupils' Workbooks and Teachers' Guides. Between 1971 and 2005, several other titles were also published by the Association.

Today, textbooks are published by STAN in Agricultural Science, Basic Science, Basic Science and Technology, Biology, Chemistry, Home Economics, Mathematics for Junior Secondary, Mathematics for Senior Secondary, and Physics.

Such has been the impact of book writing by one STA in Africa. The *multiplier effect* has indeed been remarkable and other STAs have followed this practice.

Elsewhere, Ivowi (1984) has elaborated on the *Prospect from writing projects.*
According to him, the sale of project materials (textbooks) could result in financial returns as STAN has, for example, been able to raise some revenue through royalties from books to organize conferences, seminars and courses, and sponsor its members to activities of similar professional bodies. Even so, the Association has often found itself in very difficult financial situations as royalties from its titles are sometimes not sufficient for its pressing needs. This is so because the books are sold at moderate prices to ensure 'grassroots' patronage and to achieve the goals of the Association.

Textbook production continues to evolve, but STAN has seen the need to go beyond textbooks for students and has embarked on a wider range of publications geared to professional development of teachers and teaching support materials. In so doing STAN recognizes this move has, in part, been due to the success of prior STAN training of textbooks writers over the years who are now engaged as key authors by other publishers. This is a situation in which STAN takes much pride as it allows the publication of a wider range of 'good' textbook publications from which schools can choose.

**3. Organization of In-service Training for Teachers**

In Africa, the organization of in-service training has been one of the major functions of STAs. This is usually done through conferences, workshops, and seminars. These provide avenues for the exchange of information and interaction between designers and implementers of curriculum projects thereby leading to the professional growth of teachers and school administrators. Virtually all STAs in Africa have been involved in teacher training.

In Nigeria, STAN has been holding annual conferences at the end of August. Apart from the workshops organized by the 37 branches of the Association, 15 national workshops are conducted each year. STAN spends a substantial percentage of its revenue annually on in-service teacher training.

The major in-service provision by STAN today is undertaken in liaison with partners such as UNESCO and the Federal Ministry of Education. The year 2010 sees the opening of a purpose built STAN building – STAN place – which will be a focal point for STAN teacher in-service programmes and especially for the 15 national workshops conducted each year. The STAN place will also house the STAN secretariat and, being well placed near other educational establishments such as NERDC (nigerian educational research and development council), this will enable STAN to cooperate more closely with others in the field of science, technology and mathematics education.

**4. Popularization of Science**

In Nigeria, STAN popularizes science through a STAN quiz and STAN projects competitions. The activities are directed by a national science fair co-ordinator. Science fairs provide opportunities for individuals and groups to display the various science projects which they have undertaken. A project may set out to make discovery, develop new ways of demonstrating important principles or attempt to demonstrate practical applications of known principle (figure 1).

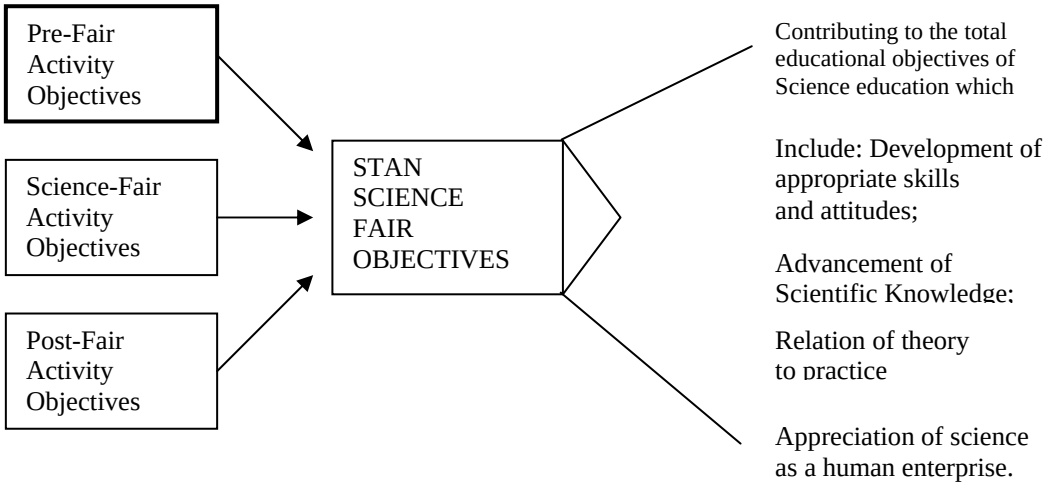


***Fig. 1*** *Objectives of STAN Science Fair*
***Source:*** *Obioha (1983:82)*

STAN activities in this area continue to develop and diversify. Today STAN is involved with television and radio programmes, especially for students in the form of competitive team quizzes.

**5. Publication of Periodicals**

STAs have also embarked upon the publication of periodicals such as journals, bulletins (newsletters) and proceedings of conferences and workshops. These publications feature articles, research reports, innovations, science notes, reviews, approaches to science teaching, trends in science teaching worldwide and updates on members.

*The Journal of the Science Teachers Association of Nigeria* originally published twice a year, is now published once annually as two issues in one volume. The Journal compares favourably with other reputable journals outside the continent (Otuka, 1993). It caters for a wide range of disciplines; Agricultural Science, Introductory Technology, Mathematics and other basic Sciences. STAN also publishes the *bulletin* twice a year as well as the proceedings of annual conferences and national workshops (see for example, STAN, 1992). In addition, the various state branches of STAN have their bulletins.

Other STAs in Africa have floated their periodicals. The newsletter of the *Lesotho Science and Mathematics Teachers Association* comes out six times a year. The newsletter has a supplement for students that contains mathematics puzzles and games, a competition and suggestion for science activities. The February 1993 issue had ideas for activities with *water drops, growing spores* and *investigating balloons.* In 1992, the African Forum for Children's Literacy in Science and Technology provided a small grant for the Lesotho Science and Mathematics Teachers Association to publish its journal for a year.

Today STAN has produced additional periodicals in the area of Environmental Education and Gender and STEM Education. The publication of the journal and bulletin continues to be a main stay of STAN.

**6. Research**

STAs have been involved in a number of research projects in STM education. The Science Teachers Association of Nigeria (STAN) for instance has embarked on several research

projects. Some of these efforts have led to the publication of the following position papers by the Association:

- What is Science?
- Women in Science, Technology, and Mathematics: The Nigerian Experience
- School Industry Link
- Raising the Standard of performance in Public Examinations in Science, Technology and Mathematics
- Humanism and the Science Curriculum

Current STAN research is geared to the promotion of entrepreneurship through relevant science, technology, engineering, and mathematics education. Research is also directed at the interpretation of education for sustainable development in a Nigerian context.

**Roles of STAs alongside the machinery of Government**

Science Teachers' Associations have been involved in Science and Technology Education formulation, working alongside Governments by:

**a. Floating a policy document**

According to Holbrook (1993), STAs are able to influence policy by creating their own policy statements and floating these so that the membership can interact and even vote. He maintains that among STA membership are influential governmental policy makers and hence the dissemination process of floating policy statements and encouraging discussion in its publications influences science education thinking as such documentation can be tabled during governmental policy meeting.

**b. Adoption of STA-initiated project by government**

Sometimes a project embarked upon, or initiated by a STA is adopted by government. In Swaziland, Slimming (1976) reports that the impetus for that country's Integrated Science project came when in 1971, the *Swaziland Science Teachers Association (SSTA)* brought to the attention of the Ministry of Education's Science Teaching Panel their dissatisfaction with the existing Junior certificate syllabuses in Introductory Science and Biology. There was concern that the new course should encourage the study of science with an emphasis on individual experimentation and on understanding and constructive thinking; and it was strongly stressed that full account should be taken of the cultural and physical environment of the country. A set of proposals was put forward and the ministry of Education invited all science teachers to a meeting to consider these. After a lively debate the proposals were unanimously accepted and the Swaziland Integrated Science project (SWISP) thus came into being in March 1972. Similarly in Nigeria, the Nigerian Integrated Science Project (NISP) (now renamed Nigerian Basic Science Project, NBSP) earlier reported on is the brainchild of STAN.

**c. Membership of Decision-Making Bodies**

The Science Teachers Association of Nigeria has been able to influence Science and Technology Education policy partly through its membership of the Joint Consultative Committee on Education (JCCE). The JCCE, inaugurated on 30 September, 1955 is Nigeria's highest advisory body on education to all governments of the Federation. It meets twice yearly and makes recommendations to the National Council on Education

(NCE) for consideration and ratification. At each meeting of the JCCE, STAN presents a report on its activities. Occasionally, the association, in addition to the report, presents a memorandum on a particular subject. One of such memoranda in 1989, led to the establishment of special science secondary schools in Nigeria. Membership of the JCCE has enabled STAN to be aware of the direction of government policy well in advance and to influence it where possible. It is interesting to note that many members of the JCCE are Co-opted members of the Governing Council of STAN. These include: the Education Trust Fund, Federal Ministry of Education, National Commission for Colleges of Education, National Examinations Council, National Teachers Institute, National Universities Commission, Teachers Registration Council of Nigeria, Universal Basic Education Commission, and the West African Examinations Council.

**d. Collaboration with Government Agencies**

Active collaboration of STAs with government agencies can lead to new science education policies. The development of the *Nigerian Secondary Schools Science Project (NSSSP)* which produced textual materials in Biology, Chemistry and Physics was due to the collaborative effort of STAN and the then Comparative Education Study and Adaptation Centre of the University of Lagos. In fact, the writers of the series were guided considerably by the syllabus outlines earlier developed by the Science Teachers Association of Nigeria at the instance of the West African Examinations Council (WAEC). Other Nigerian government agencies such as the National Teachers Institute have also been collaborating with STAN either directly or be assigning some work to some of STAN's veteran members.

**e. Memberships of Task Forces, Commissions, etc.**

STAs do influence government policy on S & T through membership of special tasks forces, commissions, conferences, etc. For instance, STAN participated actively during the nation's curriculum conference in 1992 in Kaduna. In fact, the then STAN President, Professor Uduogie Ivowi, served as the Rapporteur General. Similarly, the Association was represented at the workshop that led to the formulation of the Nigerian National Policy on Science and Technology.

**f. Holding Seminars, Workshops, and Conferences**

Holbrook (1993) has cited the holding of seminars, workshops, and conferences as a means of influencing S&T policy. He believes that the involvement of governmental personnel as participants in these workshops can strongly influence policy and gives, as an example, the increase in the level of in-service provision for teachers in Hong Kong following the 4$^{th}$ ICASE-ASIAN symposium held in Hong Kong. Similar activities by GAST in Ghana and STAN in Nigeria have always received government attention and patronage. The Science Teachers Association of Nigeria usually publishes its conference communiqué and copies are made available to government. These communiqués are highly regarded.

**Conclusion**

Innovation at the level of practice of science education is heavily dependent on the teacher. Raising the level of enthusiasm and commitment of science teachers has been shown to play an important role in more exciting science teaching. Through peer-peer collaboration and

utilising their experience, STAs provide an invaluable role in developing a more productive, innovative and enthusiastic science teaching force. Can any country afford to be without one?

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