TOWARDS MORE INNOVATIONS IN MATHEMATICS, SCIENCES AND TECHNOLOGY EDUCATION

By

Aderemi Kuku, **PhD, FAMS(USA), FTWAS, FAAS,FAS (Nig), FMAN, OON, NNOM**

Distinguished Professor, National Mathematical Centre, Abuja, Nigeria And Out-going President Africa Academy of Sciences.

SECTION 1

MATHEMATICS VIS-À-VIS OTHER AREAS OF SCIENCE AND TECHNOLOGY

1.1 Nature and Structure of Mathematics

1.1.1. Heritage Of All Mankind

-Long history with contributions from various cultures- Egyptians, Babylonians, Greeks, Arab-Islamic, Indians, Mayans, Chinese, Arabs, Europeans, etc.

-Last 600 years dominated by Europeans and cultural associates- USA, Australia, Canada, etc.

1.1.2. Various Ramifications:

-**NUMBER**-involves counting;

measurements (e.g. of length, weights); understanding of integers; rational, real, complex, p-adic numbers, etc.

-**SHAPE**-leads to studies in geometries, topology, Lie groups with applications, gauge field theories, fractals, catastrophes, attractors, etc.

-**MOVEMENT**-of waves, planets involving ODE, PDE, Fourier analysis, calculus of variations.

-**CHANCE AND RANDOMNESS**-with associated mathematics e.g. probability, statistics, stochastic diff. equations, etc.-all with added exploratory and processing powers of new technology, e.g. computers.

Cont…

1.1.3. Contemporary Methods Rather Profound, Sophisticated, Technical & Diversified.

e.g. easily stated problem like 'Fermat's last theorem ' so far solvable by highly sophisticated and abstract techniques.

- Hence global illiteracy in contemporary mathematics resulting in hostility from Institutions , Govt & Priv. sectors.

- Raise serious pedagogical issues about teaching and learning contemporary materials in mathematics

1.2. The Four Areas of Science and Mathematics

1.2.1. Basic Sciences

- Mathematics (including statistics and computer science)
- Physics
- Chemistry
- Biology (including basic medical sciences)

Cont…

1.2.2. Applied Sciences

-Medicine and health

- Agriculture (including livestock, fisheries and forestry studies)

- Earth Sciences (including Meteorology, Oceanography, irrigation and soils, minerals exploration, etc.)

1.2.3. Low Or Classical Technologies

- Iron, steel and other metal goods
- Petroleum technologies
- Power generation and transmission
- Design and fabrication industries

Cont…

1.2.4. High Technologies

-Micro-electronics (including software development, fabrication of microchips with industrial application, computer-aided design, etc.)

- Space Sciences
- New Materials (including high temperature super conductors…)
- Pharmaceuticals and fine chemicals
- Biotechnology (including molecular biology, genetics and microbiology-useful in agriculture, energy, medicine)

1.2.5. Hence, Science & Technology could be viewed as concentric layers with DIFFUSE BOUNDRIES with a central core of basic sciences and mathematics at its inner most core- theories from the inner core help to solve problems in applied sciences as well as technology while problems arising from outer layers of technology, and applied sciences provide the inner cores of basic sciences and mathematics with new structures, new concepts and new methods.

SECTION 2

THE FUTURE OF EDUCATION IN MATHEMATICS, SCIENCE & TECHNOLOGY

2.1. Mathematics, Science & Technology, Education As an Imperative For All

2.1.1 Pre-Tertiary Level :

Need mathematically literate citizens who can estimate, approximate, measure, read tables, think clearly- critically and logically.

This should inform curricula for kindergarten, primary and secondary schools.

Cont…

2.1.2 **Goal Of Tertiary Education** Include

1. Training of high and middle-level manpower.
2. Training future researchers and te for Universities, Polytechnics, colleges of education & schools.
3. Providing mathematical input into training of experts for the various professions –engineering, medicine, social sciences, agriculture, etc.

4. Fulfilling mathematical needs of the industries and Technology.

5. Creating a critical mass of mathematical scientists needed for overall social economic, scientific and technological development of Africa

2.2. Innovations In Curriculum Development And Teacher Education

2.2.1. Reasons For Curriculum Innovation

-Rapidly changing frontiers.

-Challenges posed by new and emerging technologies.

-Need to couple Mathematics education with integrated Science & Technology education at pre-tertiary levels.

-Need to incorporate "Mathematics and

Science Comprehension” in teacher education and other curricula at all levels.

-Need to adapt for schools some of heitherlo ignored fundamental Mathematics and science

-With more routine job being done by robots, current millenium will offer jobs requiring workers to absorb new ideas and solve unconventional problems.

Cont…

2.2.2. "Mathematics Comprehension"

*As an imperative for teacher and science education

-Need Mathematics and science teachers to be able to simplify some mathematics and science materials and express such materials in their own words.

-Mathematics and science teachers need to be able to write popular articles as well as write innovative books for schools.

-”Mathematics Comprehension” should become a requirement for partial fulfillment of degrees in Mathematics education; Bachelors, Masters and PhD or D.Ed.

SECTION 3

THE ROLE OF ICT

The study of all areas mentioned so far, apart from requiring Mathematics also have strong ICT components. The ICT components of various areas of science and technology have become more pronounced and prominent in this age of globalization. Indeed most recent developments all over the world have been ICT driven. Moreover, ICT has been used effectively to gather, manipulate, present, and communicate information all over the world.

More specifically,

- Bridging the technological divide between Developed and Developing countries.
- Significant growth in access to the internet
- 63% mobile penetration rate and 16% internet

  Access rate-already exists.
- Unifying themes in S & T and in various disciplines-

  must affect curriculum at all levels. e.g education, health,

  agriculture, economics, and business.

  Most global challenges can be translated into challenges Involving S & T, and ICT, hence mathematical sciences.

SECTION 4

SOME SPECIFIC INNOVATIONS

- Need modern Science and Technology integrated curricula at middle school level- especially in the developing e.g African countries where people finish their education at this level. Specialization should start at senior secondary level.
- Could borrow a leaf from Hong Kong curriculum which include art and designs and some basic engineering and technology ideas.

- Some of the necessary ideas to be imbedded in school curricula include ability to

1. Recognize symmetry, structure of crystals and the growth of organisms
2. Recognize the complexity of measurements not only geometric quantities (length, area, volume) or arithmetic quantities (size, orders and labels) but also dynamic variables (discrete, continuous, and chaotic); exploiting computer graphics which automate the process of projecting shapes in higher dimensional space.

SECTION 5

CESAME

❖ It is highly desirable for all countries in the AME regions to embrace the CESAME initiative for effective implementation of innovative science education idea. Such centres, beyond emphasising enquiry-based pedagogy (IBSE) should also renew the scientific contents of science education curricula that are best described by experts in the AEMASE Network. It is envisaged that the centres will

also organise workshops and refresher courses for science teachers and teacher trainers with the help of local experts with the Workshop resource persons also consisting of international experts from the AME region.

I support the proposal by the steering committee that the CESAME network starts relatively slowly with a few Centres—at most five within the next five years—two at first and three later—to conduct the first training programmes , co-ordinate IBSE workshops and play a major role in launching other CESAMEs.

All these efforts will eventually develop into inter-continental Network with ‘hubs’ and ‘spokes’ as outlined by the steering committee.

THANK YOU