

Regional And International Cooperation To Strengthen Basic Sciences In Africa

By

Aderemi Kuku

Grambling State University
Grambling, LA 71245, USA

-Being

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Preliminary Remarks On The Importance Of Basic Sciences

For the purpose of this discussion basic sciences include:

- a) Mathematics (including Statistics and Computer Science).
- b) Physics.
- c) Chemistry.
- d) Biology (including Basic Medical Sciences).

The need for basic sciences is particularly compelling . Africa has to be well equipped to join the developed world in facing the challenges of the future. These challenges include the inevitable change from inculcating routine skills to the ability to discern relationships, innovate, reason logically, and use a wide range of scientific methods to solve a wide range of non-routine problems encountered in everyday living, the workplace and the professions.

The General objective of scientific education at pre-tertiary level is to produce scientifically literate citizenry who can also estimate, approximate, measure, read tables, think clearly, critically and logically. Moreover, such an education should also prepare adequately those citizens who constitute middle and high-level manpower reservoir for the African continent.

The General objective of tertiary scientific education should include inculcating in the African the cultures associated with scientific training as well as understanding of science, the creation of a critical mass of basics scientists needed for the overall social, economic, scientific and technological development of Africa i.e.:

- (I) Training of high and middle-level human power for Africa.
- (II) Training future scientific researchers and teachers for research institutes, universities, polytechnics, colleges of education and schools.
- (III) Providing the scientific input into the training of experts for the various professions – e.g. engineering, medicine, social sciences, agriculture, environment, natural and other sciences and policy making.
- (IV) Fulfilling the scientific needs of the industries and technology.

- In this presentation we will examine how far we have gone in Africa towards achieving these goals and how to move forward.

Section 1

Some Reasons For Africa's Under-Development In Mathematics, Science & Technology.

1.1. Some Historical Reasons

- Africa left behind by the Radical Scientific ,Industrial & Technological Developments of the 18th and 19th centuries.
- Nevertheless, in the 60's and early 70's high-level education intellectual pursuits and creativity flourished in education Many African Universities which then compared favorably with the best in Europe, U.S.A. and U.K. from mid-70's till now, the situation has deteriorated so badly for various reasons discussed below.

Cont...

- Decline in enrolment for postgraduate studies resulting in lack of enough university science teachers – mathematical and physicists becoming “endangered species” in Africa.

1.2. Lack Of Political Will of African Leaders To Invest Massive Financial Resources In Science & Technology

- Most African countries invest only 0.1 to 0.4 % of GNP. Only South Africa and Tanzania have now invested up to the much desired 1%.

Some Reasons For Africa's Under-Development In Mathematics, Science & Technological

1.3. Debt Burden Of African Countries And Dependence Of African Economies

- Servicing debts leave relatively little resources for Development Projects (Burden now alleviated in some countries)
- Dependence on declining revenue

1.4. Lack Of Critical Mass Of Mathematics, Science And Technology Teaches and Researcher

- * Mathematics, Science & Technology expertise spread very thin all over the continent

1.5. Inadequacy Of Teaching And Research Facilities

- Laboratory, teaching and research Facilities Inadequate- Inadequate Books, Journals, Computer Facilities etc.
- Situation deteriorated since the mid-70's.
- Cause include: proliferation of Universities without adequate funds.

Cont...

1.6. High Population Growth:

* Growth rate of about 4.5% puts pressure on limited available resources and services.

1.7. Non-Adoption Of Scientific Culture.

1.8. Internal And External Brain Drain Of African Mathematicians & Scientists.

1.9. Environmental Problems

- Political instability, natural & manmade disasters, disfunctioning public utilities- Water, Electricity etc.

2.1 Nature & Structure Of Basic Sciences

2.1.1. Heritage Of All Mankind

- Long history with contributions from various cultures- Egyptians, Babylonians, Greeks, Arab-Islamic, Indians, Mayans, Chinese, Arabs, Europeans, etc.
- Last 500 years dominated by Europeans and cultural associates- USA, Australia, Canada, etc

2.1.2. Various Ramifications Of Mathematics

- **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, lanets 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.

2.1.3. Mathematics Interwoven With Other Sciences.

* Have Mathematical, Biology (Bio-mathematics),
Mathematical Physics, Mathematical Chemistry, Mathematical
Economics (Econometrics), etc.

2.1.4. Contemporary Studies In Experimental Areas Of Basic Sciences Require Sophisticated And Expensive Equipments.

2.1.5. Contemporary Methods In The Sciences 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 and science
resulting in hostility from Institutions in Govt's & Priv. sectors.
- Raise serious pedagogical issues about teaching and learning
contemporary materials in the sciences.

2.2. Basic Sciences Vis-à-Vis Other Areas Of Science And Technology

2.2.1. Basic Sciences

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

2.2.2. Applied Sciences (include)

- Medicine and health
- Agriculture (including livestock, fisheries and forestry studies)
- Earth Sciences (including Meteorology, Oceanography, irrigation and soils, minerals exploration, etc.)

2.2.3. Low Or Classical Technologies

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

Cont...

2.2.4. 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)

2.2.5. Hence, Science & Technology could be viewed as concentric circles 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.

The African Situation

- Africa has hardly a critical mass in any of the four areas of Science & Technology
- With respect to 2.2.3, some countries could afford to buy the technology-e.g..... Nigeria- to have
 - Iron and steel Industry- does not need new science
 - Self sufficiency in food production.
 - Electricity- have a big dam that even supplies electricity to neighboring countries, but fails to be self sufficient in the supply of electricity to its own citizens.
- Most African Countries feel that high technologies are beyond them. Yet the developed countries will not readily transfer their “High Technologies

Section 3

Some Impacts of Basic Sciences On Other Areas Of Science And Technology

3.1. Electrical Generation Technology

- inspired by Faraday's Theory of electricity and magnetism
i.e. Mathematics and Physics

3.2. Wave Propagation, x-rays, radios, television, oil exploration, etc.

- Maxwell Equations, Fourier Analysis's. i.e. Mathematics and Physics

3.3. Acoustics, electric currents in the brain, turbulence, stellar structures, etc.

- Fourier Analysis, Wavelet Analysis, as well as Physics and Biology.

Cont...

3.4. Computer Revolution Is Mathematics Revolution

3.4.1. Computers are a creation of Mathematics –Alan Turing's cogent and complete analysis of the notion of computation and logical proof of the existence of the universal computer.

3.4.2. Computers are also creators of new areas of mathematics- complexity theory, proof theory, theory of Algorithms.

3.4.3. Computers have recorded success in the solution of outstanding mathematical problems e.g. four color problem; classification of simple groups.

3.4.4. Computers useful for teaching mathematics-calculus, matrix algebra, probability, statistics, geometry etc.

Cont...

3.4.5. Computer useful in solving problems arising in technology, commerce, business, economics.

Computerization of essential services –payment of salaries, banking and library services, etc, have made life easier.

3.5. Subatomic Particles, Crystallography, Photochemistry Etc. - Group theory, Chemistry, and Physics.

3.6. Tracing of Hurricanes, Studying Aircraft Flight Shocks In Non-Linear Waves, Etc. –Partial Differential Equations and Physics.

3.7. Communication, Urban Planning, Neurophysiology

- Graph theory, and Biology.

3.8. Computational Models Of The Heart, Kidney, Pancreas, Ear

- P.D.E's, Physiological fluid dynamics, and Biology.

Cont...

3.9. Green House Effect

- Numerical Solution of PDE's, and Physics.

3.10. Trajectories Of Celestial Bodies, Meteorology Dynamic Systems.

- ODE, PDE, Hamiltonian Mechanics, and Physics.

3.11. Population Biology, Genetic Engineering

- Probability, Dynamical Systems, Wave Propagation, and Biology.

Section 4

Research And Networking In The basic Sciences

4.1 Mathematics

4.1.1. Mathematics Expertise In Africa-By Sub region

East Africa-Algebra (some); Analysis [Numerical, Classical, Functional, Complex]; Topology (some); Fluid Dynamics; Statistics ; Operations research (some); Graph Theory ; Geometry (some); Financial math's (some); Computer Science (some); Biomathematics; Mathematical Modeling , O.D.E, PDE.

West Africa- Algebra (some); Number Theory (some); Algebraic Geometry (some); Riemannian Geometry; Topology (some) [Algebraic, differential]; ODE ; PDE ; Analysis [functional, classical]; Harmonic analysis; Statistics; Lie Theory (some); Relativity; Numerical analysis; Control theory; Modelling; Computer Science (some) Mathematical Statistics Some)

Cont...

Central Africa- Analysis; Operations research (some); Algebra (some); Algebraic topology (some); ODE; PDE; Math Physics; Differential Geometry (some).

North Africa-ODE; PDE; Harmonic Analysis; Functional analysis; Real Analysis; Complex Analysis; Potential theory; Commutative Algebra; Mathematical Modeling; Lie groups and Representation theory; Algebraic topology (some); Differential Geometry (some); Logic and Foundations; Probability; Statistics; Mathematical Physics.

Southern Africa (including South Africa)-ODE; PDE; Algebra (some); General topology ; Algebraic topology (some); Algebraic Geometry (some); Optimization; Control theory; Combinatorics; Mathematical Modelling; Probability; Mathematical Statistics; Numerical analysis; Cosmology (some); Dynamical systems (some); Noncommutative Algebra (some); Harmonic analysis; Real analysis; Complex analysis (some); Fluid mechanics.

Cont...

4.1.2. Some Weak Areas For The Continent

- * Mathematical Statistics
- * Mathematical Computer Science
- * Algebra in a broad sense
- * Algebraic Topology
- * Differential Geometry/ Topology
- * Algebraic Geometry (including Arithmetic Algebraic Geometry)
- * Dynamical Systems
- * Lie Groups
- * Lie Algebras

Cont...

4.1.3. Remarks

- Publications: generally modest in International Journals yet some strong publications do exist.
- No critical mass in any field of Mathematics. However, virtually all fields are represented somewhere on the continent.

4.1.4. Some Mathematical networks In Africa With International Collaborators And Cooperation

A) Networks on Modelling and Control

- 1) East African Universities Mathematical Program (EAUMP).
- 2) RAMAD- connecting some countries in West Africa.
- 3) Research areas covered include: epidemiological, ecological, hydro dynamical modelling; modeling of pollution of ground water.

These Networks are being funded and supported by International Science Programme (ISP) Uppsala University, Sweden, as well as CIMPA and ICTP.

Cont...

B) GIRAGA (Group Inter-African De Recherché De Analyze Geometrie Et Application)

- Connecting institutions mostly in West and Central Africa.
- Research areas: Analysis, Geometry and Applications.
- This Network has obtained substantial support from CIMPA, UNESCO, ICTP, DAAD, Belgian Government.

C) AMMSI (African Mathematics Millennium Science Initiative)

- Part of a global network (MSI- Millennium Science Initiative).
- Connecting all African countries through a task force made up of African Mathematicians from all sub regions.
- This is supported by some foundations e.g. Mellon foundation with linkages to AMU, AAS, TWAS, CIMPA, and LMS.

D) RAGAAD- Reseau Africain de geometrie et Algebra applique'e de developement – supported by CIMPA and ICTP, etc.

Cont...

E) Some Dormant Networks

- 1) African Mathematical Union (AMU), Pan-African Mathematical Sciences Network.
- 2) Mathematics and its Uses in Southern Africa (MUSA).
-connecting countries in Southern Africa.

4.1.5. Some Mathematical Centers:

- 1) (NMC), National Mathematical Center, Abuja, Nigeria.
 - supported mainly by the Nigerian Government.
- 2) (IMSP), Institute de Mathmatiques et de Sciences Physiques, Universite' d'Asomey, Calavi, Benin (Porto-Novo)
 - supported by ICTP Belgium Government, TWAS CIMPA, and EU.
- 3) (AIMS), African Institute of Mathematical Sciences, Capetown, South Africa.
 - supported by the South African Government, NEPAD, Vodacom, Gatsby, Mellon, and Ford Foundations
- 4) (IRMA), Universite' de Concodey, Abidjan, Cote D' Ivoire.
 - supported mainly by the Government of Cote D'Ivoire.
- 5) National Centre for Mathematical Sciences, Accra, Ghana.

Cont...

4.1.6. Some Regional And Sub-regional Math Societies

A) African Mathematical Union (AMU)

- Founded In 1976, AMU organizes many mathematical research and education activities all over Africa. It has four commission

- AMU commissions on

- (1) Mathematics Education

- (2) History of Mathematics in Africa

- (3) Pan-African Mathematics Olympiads , and

- (4) Women in mathematics in Africa.

B) SAMSA- Southern Africa Mathematics Association

4.2. PHYSICS

In most African Universities and Tertiary Institutions, well trained Physicists, like Mathematicians, are generally becoming endangered species.

When the present generation of University teachers and researchers in Mathematics and Physics, disappear from the scene due to retirement etc., the situation will be near disaster unless urgent steps are taken.

Physics Centers Promoting Research And Networking

4.2.1. National Institute for Theoretical Physics, South Africa

- Gives high priority to producing high quality graduates in Mathematics and Physics.
- The institute plans to make impact on the Continent.

4.2.2. National Astrophysics and Space Sciences Programme, Capetown, South Africa

- Uses the Universities to provide education and training
- Science based at the University of Cape town but all Universities involved take an initiative in developing and delivering courses as well as host students for research projects.

4.2.3. African Physical Society

- Promotes Science, Mathematics, Technology education in Africa.
- General collaborations among African Physicists WORLDWIDE.
- Publicize Progress in Physics research and education in Africa.
- Publishes African Journal of Physics.
- Promotes networking among other Physical Societies and initiatives in and outside of Africa.

4.2.4. African Advances Institute for Information and Communication Technology

- boosts research in computational sciences

4.2.5. African Materials Research Society

- Promotes African Laser Center
- Funded by South African Government, NEPAD and ALL.

4.3. CHEMISTRY

4.3.1. Pan-African Chemistry Network

- Have hubs in Kenya (University of Nairobi) Ethiopia (University of Addis Ababa) and South Africa (Johannesburg and Capetown)
- Organizes research collaborations North-South and South-South.
- Provides resource materials for effective teaching in the Universities and other tertiary Institutions.
- Organizes workshops/conferences and awards fellowships (scholarships)

4.3.2. Federation of African Societies of Chemistry

- promotes advancement of chemical Sciences and the practice of Chemistry that will impact on development aspirations of Africa.
- Cooperates with various International Organizations
 - UNESCO, RSC (Royal Society of Chemistry), IUPAC, EuChems, etc.
- Together with UNESCO and the Government of Ethiopia succeeded in getting the year 2011 declared by UN as the International Year of Chemistry.

4.4. BIOLOGY

4.4.1. African Society for Computational Biology

- Organizes various activities in Africa in cooperation with the International Society for Computational Biology.

4.4.2. African Network for The promotion of Conservation Biology

- This is in cooperation with the AAS and the International Society for Conservation Biology

4.4.3. African Institute for Bio-Medical Science and Technology

- Cooperates with WHO and the National Institutes of Health.
- Centers for Disease control and prevention.
- promotes Bio-bank and Pharmacogenetics database of African populations – which deals with collection and preservation of biological material for biomedical research in Africa.

5.1. African Academy of Sciences (AAS)/UNESCO Project Proposal For Capacity Building In Africa In The Basic Sciences

A) Rationale For This Project

- Basic Sciences constitute the foundation of all scientific, technological, innovation, social and economic development of Africa.
- The sorry state of basic sciences all over the continent creates a compelling and urgent need for this project.
- African Academy of Sciences (AAS) is a Pan-African organization with members who are distinguished specialists in most aspects of Science and Technology and can mobilize its members for secretariat for providing effective solutions to the basic sciences problem.
- UNESCO has an International Basic Sciences programme and so, AAS and UNESCO can effectively collaborate towards the solution of this problem.

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B) Pan-African Network For Research And Education In The Basic Sciences

(a) Aims And Objectives Of The Network

- 1) To produce adequate staff in universities, polytechnics, colleges of education and research centres in order to meet the growing requirements in these institutions.
- 2) To accelerate the evolution of members of the network as centres of excellence for research and training in the basic sciences.
- 3) To elevate brain drain by getting young Africans to register for higher degrees at institutions constituting members of the Networks with exposures to facilitate abroad while working on their theses.
- 4) To encourage North-South and South-South cooperation in the areas of research and training of graduate students for higher degrees of African universities.

Cont...

5) To bridge isolation gap among African scientists through development of research groups in a number of institutions of the network eventually leading to the production of critical mass of African scientists so badly needed for the development purposes.

(b) Proposed Programmes For The Network

1) Professors from within and outside the network could be invited from time to time to visit members of the network, give lectures and contribute towards the development of research expertise at the host institutions.

2) Graduate students and staff from members of the network will be given the opportunity to spend some time – up to a maximum of one year- at centres of excellence outside Africa to get better exposed.

3) Special effort will be made to improve the library and laboratory, and other facilities of members of the network (both at undergraduate and graduate levels) to facilitate productive research by students and staff as well as effective teaching at both undergraduate and graduate levels.

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4) Efforts will be made to initiate PHD programmes at some of the members of the network in desirable areas of basic sciences in the continent with the cooperation of professors from abroad.

5) Cooperation between members of the exchange of staff and students, as well as maximizing use of facilities will be special features of the network.

(c) Proposed Members Of The Network

It is suggested that the network consists of about 30 carefully chosen universities/research centres from among those which already have some basic facilities and good quality staff that can more easily be upgraded such as:

- 1) University of Yaounde' (I), Cameroon
- 2) University of Ghana, Legon, Ghana
- 3) University of Abidjan, Cote D'Ivoire
- 4) University of ibadan, Nigeria
- 5) University of Khartoum, Sudan
- 6) University of Mohammed V, Rabat, Morocco
- 7) University of Nairobi, Kenya
- 8) Makerere University, Kampala, Uganda

Cont...

- 9) University of Tunis, Tunisia
- 10) University of Cape Town, South Africa
- 11) University of Zimbabwe, Harare, Zimbabwe
- 12) University of Cairo, Giza, Egypt
- 13) University of Cheick Anta Diop, Dakar, Senegal
- 14) University of Dar es Salaam, Tanzania
- 15) University of Nigeria, Nsukka, Nigeria
- 16) Eduardo Mondlane University, Maputo, Mozambique
- 17) University of Addis Ababa
- 18) University of Kennesaw
- 19) Wits University, Johannesburg
- 20) University of Botswana
- 21) Ahmadu Bello University, Nigeria

Cont...

Some Basic Science Centres

- 22) International Centres For Insect Physiology and Entomology (ICIPE), Nairobi, Kenya
- 23) Institute de Math et Sciences Physiques, Portonov, Benin Republic
- 24) National Mathematical Centre, Nigeria
- 25) National Mathematical Centre, Accra, Ghana
- 26) AIMS – African Institute for Mathematical Sciences, Cape Town, South Africa
- 27) AMMSI – Africa MSI
- 28) National Institute for Theoreticall Physics, South Africa
- 29) International Chair in Mathematical Physics and Applications (ICMPA) Cotonou, Rep. of Benin

Cont...

(d) Organization of Workshops, Conferences, etc.

*AAS/UNESCO in cooperation with other organizations will sponsor and/or organize workshops or conferences at regional and sub-regional levels in various of the basic sciences, especially contemporary and areas of weakness for the continent.

(e) AAS/UNESCO Tertiary Text-book Development Projects

*AAS/UNESCO in cooperation with other organizations e.g. TWAS will organize workshops or conferences at regional and sub-regional levels in various areas of the basic sciences, especially contemporary and areas of weakness for the continent.

(f) AAS/UNESCO Donation Programmes For Books, Journals, And Computers To Institutions In Africa, Especially Members Of The Network In (I)

*AAS/UNESCO should either independently or join forces with those already involved with getting individuals and/or institutions to donate books, journals, computers to African institutions.

(g) AAS Prizes In Basic Sciences

(h) Award Of Research Grants With Special Considerations
For Women Scientists In Africa

C) Capacity Building At Pre-Tertiary Level

(a) Popularization Of Science/Inculcation Of Scientific
Culture

General Comments

- 1) Print and electronic media.
- 2) Science museums and centres with participatory hands-on and interactive exhibits.
- 3) Open days and demonstration by science research institutes
- 4) Science clubs in schools.
- 5) National science weeks.
- 6) Various adult science education programmes.
- 7) Various science Olympiads.
- 8) Popular writing explaining various areas of contemporary science in simple language.

Cont..

D) Some Further Specific Project Proposals

1. AAS Special Publications On Popular Scientific Articles

*ASS should initiate new publications aimed at explaining contemporary sickness as well as recent discoveries in simple language. ASS should also encourage national scientific organizations to initiate such publications

2. AAS/UNESCO To Champion Creation Of Science Museums All Over The Continent

*AAS should sensitize African Governments through AU, NEPAD, etc to have science museums at country capitals and/or state capitals where the public can go to get acquainted with various scientific developments hands-on.

3. AAS Commission On Science Olympiads

*AAS should set up a Commission on Science Olympiads that will have responsibility for organizing science Olympiads all over the continent.

Cont...

4. Workshops For Science Teachers In Schools And Colleges Of Education

*ASS should find funds to support workshops or refresher courses on topical issues in science especially getting teachers and educators to understand and simplify high level ideas in science in order to write innovative books for school.

5. AAS programmes To Provide Incentives In School Towards Careers In The Science With Special Attention To Women

E) Expected Results and Follow-Up

The initiative is expected to have the following results:

- Large number of middle-level human power produced
- Increased number of African scientists and teachers produced
- Improved transfer of scientific information
- Improved cooperation between North-South, South-South scientists and institutions
- Improved infrastructures and facilities for scientific research and education
- Improved communication among scientists and co-operation in research
- Reduction in brain drain (both internal and external)
- Improved condition of work in the universities and research institutions
- Exchange of experience and information through workshops and conferences

- Large number of books on specific basic science published
- More books, journals, and computers donated and distributed
- Awards in basic sciences research grants
- Basic sciences popularized among general public, policy makers, and young people
- More popular scientific articles written and distributed to general public
- Science museums established
- Science olympiads commissioned
- Awards of incentives in schools toward careers in science with particular attention to women and the disabled

Section 6

THE WAY FORWARD

- 6.1. The AAS/UNESCO project proposal on capacity building in Basic Sciences should be adopted as AU/NEPAD flagship programme.
- 6.2. African Governments Should Demonstrate Political Will For Radical Increase In Funding For Mathematics, Science & Technology.
- 6.3. Inculcate Scientific Culture Through Popularizations Of Science.
- 6.4. Effect Radical Improvements In Teaching And Research Infrastructures And Facilities.

Cont...

6.5. Closer Links Between Universities, Research Institutes And Industries Should Be Developed.

6.6. Existing Networks In Mathematics, Science & Technology Should Be Strengthened And New Ones Created.

6.7.. Attract Good Students And Personnel For Careers In Basic Sciences.

6.8. Strengthen Existing Centers Of Excellence And Create New Ones.

6.9. Stem Brain Drain In The Basic Sciences.

Cont...

6.10. Turn Brain Drain Into Brain Gain.

6.11. Invest Heavily In Tertiary Text Book Development In The Basic Sciences.

6.12. Level Of Scientific Research Outputs In Africa Should Be Radically Improved.

6.13. Africa Should Leapfrog Into Scientific Frontiers And High Technologies.

6.14. Identify Contemporary Areas Of Basic Sciences Yet To Be Developed In Africa.

Cont...

6.15. Multi And Bilateral Projects And Cooperation Should Be Intensified.

6.16. AU And All African Countries Must have Science & Technology Policies.

6.17. Establish Pan-African Prizes In Various Areas Of Basic Sciences.

6.18. Remove Artificial Boundaries Between So- Called Pure And Applied Sciences.