THE NIGERIAN ACADEMY OF SCIENCE

Science, Technology, and Innovation: Education and Manpower Development in Africa

Summary of Conference Presentations

40TH ANNIVERSARY
AND
THE THIRTEENTH ANNUAL MEETING OF AFRICAN SCIENCE ACADEMIES (AMASA-13)

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About the Nigerian Academy of Science

The Nigerian Academy of Science (NAS) is the foremost independent scientific body in Nigeria which was established in 1977, and incorporated in 1986. The NAS is uniquely positioned to bring scientific knowledge to bear on the policies/strategic direction of the country, and is also dedicated to the development and advancement of Science, Technology, and Innovation (STI) in Nigeria.

The aims and objectives of the Academy are to promote the growth, acquisition, and dissemination of scientific knowledge, and to facilitate its use in solving problems of national interest. The Academy strives to do this by:

- Providing advice on specific problems of scientific or technological nature presented to it by the government and its agencies, as well as private organizations.
- Bringing to the attention of the government and its agencies problems of national interest that science and technology can help solve.
- Establishing and maintaining the highest standards of scientific endeavours and achievements in Nigeria, through the publication of journals, organization of conferences, seminars, workshops and symposia, recognition of outstanding contributions to science in Nigeria, and the development of a working relationship with other national and international scientific bodies and academies.

As with national academies in other countries, NAS is a not-for-profit organization with membership comprising 248 Fellows elected through a highly competitive process, who have distinguished themselves in their fields both locally and internationally. Some of her members have served as Vice-Chancellors of universities, Directors-General of government parastatals, and Ministers in federal ministries. The Academy, given its clout, also has the ability to attract other experts from around the country and internationally when needed.

The NAS is Nigeria's national representative on such bodies as the International Science Council (ISC) – the umbrella body for all science associations and unions, and the InterAcademy Partnership (IAP) – the umbrella body for all national science academies globally. The Academy is also a member of the Executive Committees of the InterAcademy Partnership for Research (IAP-R), and the Network of African Science Academies (NASAC).

Foreword

This report contains the summary of the presentations made during the Thirteenth Annual Meeting of African Science Academies (AMASA-13), hosted by the NAS as part of events that marked the Academy's 40th anniversary celebrations.

For the last forty years, the NAS has served as the voice of science in Nigeria, drawing the attention of relevant stakeholders to national issues of scientific importance. From its inception in 1977, with a Fellowship of forty-two Foundation Fellows, the Academy's membership has grown to 248 Fellows from diverse disciplines of science. More importantly, in its first forty years, the Academy has contributed significantly to the scientific landscape of Nigeria, raising awareness on issues of national importance, organizing capacity building activities for various stakeholders, and fostering partnerships within and outside the nation's scientific community. To commemorate this landmark anniversary, it was therefore fitting for the NAS to host the AMASA-13 conference; bringing the African and international scientific communities to Abuja, Nigeria.

The yearly AMASA conference serves to strengthen relationships and foster cooperation between African science academies, and their governments, as well as to build the capacity of African science academies as providers of evidence-based science for policymaking. The focus of the thirteenth edition of this international conference which took place on the 15th and 16th of November 2017, was to draw attention to Science Technology and Innovation (STI) education and manpower development on the continent, with a view to formulating strategies that would lead to positive reform in the sector. Science education- as with education in general- is a vital part of any society. The level of development in any society, country, or region, is a reflection of the quality of science education that is obtainable in it. One of the developmental goals set by the United Nations is to promote quality education globally. Academies of science across the globe play a vital role as advisers to relevant stakeholders in their respective countries/region.

In line with this, the NAS thought it expedient that science education and manpower development be the focus for the AMASA-13 conference.

In Africa, there are several challenges facing science education and manpower development; some of these include inadequate funding for the education sector, lack of policies that support Science Technology Engineering and Mathematics (STEM) education, ill-equipped educational institutions, and brain drain. These challenges are not unique to one region of the continent, but cut across all regions. To address these, it is crucial that all stakeholders including policy makers, scientists, and educators work in tandem.

This report details the perspectives of experts (academics, policymakers, and representatives of the private sector) from within and outside the continent, on what should be done to reform STI education on the continent. It is the hope of African science academies that the recommendations contained herein will guide policymaking for the revitalization of science education and manpower development in Africa

Professor K. Mosto Onuoha FAS
President, NAS

Speech by the Honourable Minister of Science and Technology

I am indeed honoured to be invited to serve as the Special Guest on this auspicious occasion. May I, on behalf of the Federal Ministry of Science and Technology, congratulate the NAS on its 40th anniversary, and also for hosting the AMASA-13 conference. May I also welcome Fellows of other African science academies to Nigeria.

The choice of "Science, Technology and Innovation (STI): Education and Manpower Development in Africa" as the theme for the occasion is a realistic recognition of the immense contributions of science and technology as a tool for economic development not only in Africa but all over the world. It is a well-known fact that STI has continued to propel the global economic landscape into rapid changes. These global changes are creating considerable new opportunities by conquering hitherto unimagined frontiers in engineering, medicine, space, agriculture, transportation, industry, and commerce. Major transformations in national economies are being driven by significant advancements in STI that are changing human lives through better, neater, healthier, and more beneficial environments, effective education, better resource management and controls, information and communication technology breakthroughs, cleaner and renewable energy, energy efficiency, sustainable water supply, nutrition, robotics etc. It is therefore obvious that if Nigeria, given its natural endowments and human capital, is to successfully transform its economy and take its rightful place in the community of nations, STI and its integration in national socio-economic development processes must be accorded the highest priority to pursue basic developmental benchmarking templates, like the Sustainable Development Goals (SDGs). It is in this regard that our government, under the leadership of President Muhammadu Buhari GCFR, calls for a fundamental and far-reaching re-orientation of the Nigerian state by recognizing the significance of STI in its *Economic Recovery and Growth Plan (ERGP)* meant to diversify the economy, create jobs, and reduce poverty.

To this effect, government has, this year, approved the implementation of the STI Roadmap 2030 derived from the National STI policy, and the guidelines for procurement of STI components, all developed by my Ministry, with the objective of promoting indigenous human capital, innovations, and technologies to facilitate diversification, and sustainable growth of the economy.

The government is committed to the administration of the nation's STI policy by supporting and complimenting the untiring efforts of its scientists, engineers, and technologists, including international cooperation; especially the types of activities and efforts of such literary bodies like the Academy of Science, and the Academy of Engineering. To this effect, the National Research and Innovation Council (NRIC), chaired by Mr. President, first met under this government. Our government has also approved the establishment of the National Research and Innovation Fund (NRIF) to be funded by 1% of the nation's Gross Domestic Product (GDP), and other sources. These efforts by our government are to change the economic paradigm from commodity marketing to knowledge-based economy. The Federal Ministry of Science and Technology recognizes some distinctive roles of academies in their defined interventions to investigate, examine, experiment, and report upon any subject of science and technology, whenever called upon to do so by government and the society. Indeed, as great questions involving developmental challenges confronting the nation arise, you will be required from time to time to assist government and society to proffer solutions. There will also be the need to bring into co-operation existing governmental, educational, industrial, and other research organizations with the object of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of Nigerian industries, the employment of scientific methods in strengthening the national economy, and such other applications of science as will promote national security and welfare.

Finally, the Federal Ministry of Science and Technology therefore wishes the Academy fruitful deliberations in the remaining activities for this 40th anniversary, and also wishes Fellows of other African science academies a pleasant and memorable stay in Nigeria.

Long live the Federal Republic of Nigeria.

Dr. Ogbonnaya Onu, FAEng
Honourable Minister of Science and Technology

Summary

The 13th Annual Meeting of African Science Academies (AMASA-13) was a two-day meeting held on the 15th and 16th of November, 2017 at the Reiz Continental Hotel, Abuja-Nigeria. It was attended by 120 participants, including representatives of African science academies, African scientists, policymakers, as well as the media.

The theme of the meeting was Science, Technology, and Innovation: Education and Manpower Development in Africa, and the objectives of the conference were:

1. To convene a regional meeting of African science academies and key stakeholders to discuss solutions to Science Technology and Innovation (STI) education and manpower development issues in Africa.
2. To discuss how science education and manpower development can accelerate Africa's growth to meet globally acceptable standards.
3. To initiate a long-term engagement plan for African science academies and their respective governments/policymakers to work together towards a new era of STI development for a more sustainable and self-reliant Africa.

The opening session had messages from the President of the Nigerian Academy of Science (NAS), Professor Mosto Onuoha FAS, as well as Dr. Yousuf Maudarbocus, the Vice- President of the Network of African Science Academies (NASAC). Goodwill messages were also given by the Chairman of Vitafoam PLC, Dr. Bamidele Makanjuola, and the Managing Director of Schlumberger, Mr. Ifeanyi Nwabogu. Their messages centered on the importance of science for national development, and the role of science academies in ensuring that science and/or research does not remain in the laboratories but are used for national development. They stressed the need to foster increased collaboration between the industrialists and the

academia, and charged NAS and other academies across the continent to midwife workable collaborative schemes between scientists in applied research and industry.

They also urged academies to consider setting up committees that will comprise of Academy fellows and industrialists, whose mandate will be to find ways to stimulate collaboration between the academy and the private sector, as well as encourage the private sector to seek needed expertise from within instead of seeking abroad, which has unfortunately become the norm now. The academies and captains of industries should be working together towards national and regional development.

The first session on 'STI Education and Manpower in Africa' discussed STI policies and prospects in Africa, as well as STI education and manpower capacity development case studies, success stories, and challenges from different regions in Africa. The presentations from the different regions showcased the fact that many nations on the continent are facing similar issues in these areas and, consequently, the major recommendation that there should be regional collaboration in overcoming these issues.

Session two on 'STI and Sustainable Development in Africa' discussed the place of STI in Africa's development. Presentations were made on the significance of basic sciences in the socio-economic development of Africa as well as the importance of building partnerships for sustainable development in Africa. Grantees of the Leading Integrated Research for Agenda (LIRA) 2030 made presentations on their on-going projects which are multi-national, interdisciplinary and collaborative researches.

Session three was a panel discussion on 'Safeguarding Africa's Scientific Future through STI Education especially of women and young scientists. The lead discussant, Dr. Himla Soodyall, of the Academy of Science of South

Africa (ASSAf) emphasized the fact that science in this generation has a wider variety of disciplines than was available several years ago, creating an overlap of disciplines and this is a strength that should be used in national development. During the discussion, it was advocated that science should be taught from the early years in more practical and applicable ways, and that there should be an increased focus on mentorship by the older scientists in academia and industry in the primary and secondary schools.

Day two commenced with a panel discussion on 'Securing Investments for Science'. In his presentation, the lead discussant, Dr. Umar Bindir, stated that intellectual property in many countries on the continent is mainly used to solve issues of poverty. Whilst that is commendable, it is not enough to move the continent forward. Intellectual property must be able to demonstrate value for money and ultimately, return on investment. He stressed that tertiary institutions should be able to commercialize their intellectual property to make themselves self-reliant. The panel agreed that for this to happen, strong linkages must be established between the institutions and the industry. One of the recommendations on how to achieve this is the setting up of a committee composed of academics and industrialists and whose main objective is to establish/explore possible collaboration between academic institutions and industry.

The final session of the meeting was a panel discussion on 'Building the Science-Policy Nexus in Africa'. The lead discussant, Dr. Jonathan Fanton, President of the American Academy of Arts and Sciences (AAAS) spoke on 'Connecting Science to Policy' from his insights from USA and Africa. He spoke on the need for African governments to invest more in basic research which is more likely to result in path-breaking discoveries. Another discussant emphasized the importance of communication between the scientific world and the society. He spoke about the need for scientists to tap into organizations like The Conversation Africa whose mandate is to work with scientists on their research work, break it down into language non-scientists can understand, and publish it.

Initiatives like this will ensure the right people are getting the information the scientists are trying to promote, and thus bring about national development.

The meeting ended with remarks by the President of NAS who thanked all in attendance for coming and expressed his hopes that participants would go back to their countries with plans to engage their industrial sectors and government and improve collaboration among all sectors to bring about national development. He also gave a charge to all the African academies of science to collaborate more on tackling their common issues and bring about the much-needed development on the continent.

Keynote Address: Repositioning Science, Technology, and Innovation through Education and Manpower Development for Sustainable Growth in Africa

Robert Ajayi Borrofice OON
Chairman, Senate Committee on Science and Technology, and Professor of Zoology

Africa cannot and should not expect rapid and sustainable development if it fails to confront the tough but surmountable challenges bedevilling STI on the continent. The time is now to encourage and mobilize heads of governments, and decision makers to confront and deal with these challenges. The main challenges within the STI-Education sector in Africa include a lack of quality education, unavailability of adequate manpower, as well as the inability of Africa to cross the bridge linking output from STI to the consumer market.

Repositioning the current state of STI on the continent will enhance the actualization of sustainable development. STI needs to be seen and adopted as the driving and centrifugal force of every nation's growth plan. Mainstreaming STI in the economic policy of a nation is strategic and acknowledges the fact that STI is a driving force for economic development. The Minister of Science and Technology should be part of the nation's economic team. This will translate to STI being a top priority on the agenda of the country.

Another significant step is ensuring that every country has a bill passed into law concerning research and innovation that encourages the private sector to make financial contributions towards education, training, and research as it relates to STI, and provides a legal framework for such investments and contributions. In most countries, the major proportion of domestic contribution to research and development (R&D) activities is provided by the government.

Having a National Research and Innovation Fund Act can provide a public-private partnership approach to funding which can aid the funding of research institutes, and enhance their capacity to offer scholarships to students studying STI at all levels. In this regard, the United Nations Educational, Scientific ,and Cultural Organization (UNESCO) has made tremendous interventions in the development of common African STI indicators, organized West African regional capacity building workshops in STI policy and statistics, and sponsored regional workshops for STI policy review in many countries.

It is important that STI is looked at beyond the traditional science disciplines of physics, chemistry, biology, and mathematics, and incorporates the appreciation and understanding of nature as well. Science, Technology, Engineering, and Mathematics (STEM) should not only be adopted as subjects in primary or secondary schools across African countries, but should be embraced as a way of life.

Africa must continue to support the teaching of science and mathematics in schools, and must continue to pursue deliberate policies that attract more people to science. There needs to be continued support for improved quality of education, thus African nations should be encouraged to adopt strategies and/or incentives that embrace teacher education and training programs, as well as supportive measures for doctoral and post-doctoral studies. There should also be a periodic review of the education curriculum in order to ensure a robust educational system that is able to tackle present challenges and fulfil national aspirations. If more Africans are equipped with the skills required to contribute towards innovation and are inspired to embrace innovation-related vocations and occupations, Africa could record an increase in innovation capacity.

On the issue of manpower development, "brain drain" remains a serious challenge in Africa. While the root cause of this reflects the challenges faced on the continent, they can be well turned into opportunities if better effort is made to encourage our skilled workforce to stay back and work at home. The African Technology Policy Studies Network (ATPS) has promoted the idea of "fifarization" of STI as a tool to address brain drain. The idea is a semblance of the Federation Internationale de Football Association (FIFA) model, and it proposes an arrangement where African scientists working abroad can return to their home countries on loan when needed to contribute to the advancement of STI and return to their foreign base upon completion of their tasks.

The Africa Capacity Report 2017 urges African governments and the African Union (AU) to vigorously pursue new and innovative funding alliances involving bilateral and multilateral donors, governments, and non-state actors like private foundations and businesses. A dedicated percentage of all loans and grants from developmental partners should go into STI capacity programs.

The African academies are urged to continue to support their ministries of science and technology especially when called upon to assist, the government and society to proffer solutions. There is also the need for academies to foster relations existing between educational, governmental, industrial, and other research organizations to further strengthen the national economy and promote national security and welfare.

Session 1: STI Education and Manpower in Africa

Africa's Agenda for Science Education and Manpower Development: Policies, Programmes and Implementation

Ahmed Hamdy
Executive Director, African Scientific Technical Research Commission (AU-STRC)

Science and Technology (S&T) have been on top of the political agenda of the AU since its inception in 1963, first as the Organization of African Unity (OAU), and now in its present iteration. Since then, landmarks of the journey have included:

- 1963 – Kwame Nkrumah's message which was an expression of a dream and an aspiration.
- 1980 – The Lagos Plan of Action which was the expression of the key role of S&T, and the allocation of 1% GDP for S&T in all countries
- 1987 – 1st Congress of Scientists in Africa which saw the creation of the Pan African Union of Science and Technology (PUST) with its headquarters in Brazzaville, and June 30th each year declared as the S&T African Renaissance Day.
- 2005 – The Consolidated Plan of Action which joined the S&T vision, plans, and actions of AUC, and New Partnership for Africa's Development (NEPAD).
- 2007 – Addis Ababa Declaration on S&T.
- 2014 - Science, Technology, and Innovation Strategy for Africa 2024 (STISA 2024).

The African Union vision is to see STI as a tool/ mechanism for Africa's transformation into an innovation-led economy. The STISA 2024 is the first decade incremental strategy designed to address Africa's challenges with the ultimate goal of contributing significantly to the AU Agenda 2063.

STISA 2024 has four pillars and six priority areas. Its pillars include building research infrastructure, enhancing technical and professional competencies,

fostering innovation and entrepreneurship, as well as creating an enabling environment for STI. The six priority areas are the eradication of hunger and attainment of food security, prevention and control of diseases, communication (physical and intellectual mobility), protection of our space, live together and build the society, and wealth creation.
A policy analysis, designed to ensure domestication and implementation of STISA by member states and Regional Economic Communities (RECs) identified the existence of policy gaps and institutional arrangements in majority of them, and also identified which are pertinent for STISA integration into national and regional STI processes.

Despite the commitment of the AU heads of states and governments to invest 1% GDP in science and technology as in the Addis Ababa Declaration on S&T in 2007, it has been difficult to access these funds mainly because it is not understood what STI contributions to GDP are. National development plans on health, industrialization, and food security are at top of the STI development agenda. Thus, STI should be available to proffer solutions; and be the service provider of development plans for all sectors of the economy. There needs to be a new mindset when developing research plans and projects so that STI can bring about/translate to inclusive innovation, community STI, and entrepreneurship.

Science, Education, and Manpower Development in Southern Africa: Successes, Challenges, and Prospects

Barney Pityana
Vice-President, Academy of Science of South Africa (ASSAf)

"The quality of an educational system cannot outstrip the quality of its teachers. Invest in teacher development and one generation of pupils after another will benefit from teachers who are confident and competent to teach".

- Professor Jonathan Jansen, President ASSAf

Many countries within Southern Africa rank low in the 2016 World Economic Forum's (WEF) Global Information Technology Report. The ranking is based on the quality of mathematics and science education. Challenges identified include:

- Inadequate budgetary allocation for education: Though many governments allocate asignificant amount of money to education, it is still inadequate.
- Insufficient infrastructure such as school laboratories, equipment, and materials forexperiments for ever increasing numbers of pupils.
- Insufficiently trained and, oftentimes, unqualified teaching personnel, especially at the foundation stages i.e. primary and secondary education.
- Science being perceived by sections of the populace as exclusive to the clever students.
- Inadequate communication and engagement effort with the public.
- Language barrier: The first language in majority of the population in Southern Africa is not English. Therefore, it becomes a problem/issue when science is taught in English, especially in the rural primary schools.

Despite the many challenges, there have been some success stories. For example, in Zambia, the use of mobile science laboratories has significantly improved the training of teachers and understanding of students.

Also, in Zambia, a collaboration between two NGOs ensured that two secondary schools were provided with a mobile chemistry laboratory, computers, and solar panels to aid in the teaching of science. The performance of the students improved by 20%.[1]

Malawi has made science compulsory in secondary schools. A science centre was also successfully launched in a bid to improve public engagement with science and increase access to science concepts.[2]

Recommendations to improve the current state of science will include:

- Improving the quality of basic education teaching in primary schools; particularly in science subjects, so as to stimulate the mindset and curiosity of students, which will be critical in creating a pipeline of secondary school students who have a good foundation, and will eventually study graduate and post-graduate courses in science.
- Harnessing advances in technology in order to enhance the teaching of science education, especially at the primary and secondary school levels.
- Increase in funding for research
- Increase in the use of Inquiry-Based Science Education (IBSE) at the primary school level. This is a role the academies of science can play very well i.e. advocating for the use of IBSE.
- Increased effort in science communication and engagement with the public on the importance of science and its applications. Scientists also need better training to communicate their research with industrialists and developmental partners.
- Increased funding in educational institutions, and the involvement of developmental partners (NGOs, private organizations) in research funding.

1 JICA. (2014). Zambia's Education Challenges – Affordable and Simple Solutions. [online] Available at: https://www.jica.go.jp/english/news/focus_on/partnership2014/partnership_04.html [Accessed 25 Oct. 2017].

2. Gondwe, M. (N.D.). [Blog] African Science Heroes. Available at: https://afrisciheroes.wordpress.com/malawi-science-centre-project/ [Accessed 25 Oct. 2017]. IT NEWS AFRICA. (2017). Mauritius: Learners to receive PC tablets in 2018.

Science Education, and Manpower Development in Uganda: Building a Complete Cycle

David Bakibinga
Secretary General, Ugandan National Academy of Sciences (UNAS)

Uganda's story on the state of science is slightly different from most of those told across the continent. Uganda has experienced an increase in investments and enrolment, and a clear bias on the part of the national leadership towards science and technology (13.47 % of the national budget was allocated towards education in 2014/2015). However, despite this increase in investment, Uganda is one of the poorest performers on the continent in terms of competitiveness, and reduction of poverty. Learning outcomes, especially in science and numeracy remain low, and there is limited success in business incubation with 0 out of 25 small and medium-sized enterprises (SMEs) graduating from the national incubation institute, despite the demand for financial capital.[3]

The major challenge identified is an incomplete cycle of innovation which is an iterative process of learning, adaptation, and evaluation that is repeated as circumstances change in response to the learning that takes place. For there to be a complete cycle of innovation, there has to be a clear linkage between innovation and its beneficiaries.

The academia and academies of science can proffer solutions to this challenge by participating in research and activities that will challenge continued learning, adapting, and evaluation of contributions to the innovative process. In practice, this means that the academia needs to be as inclusive as possible of organizations and individuals outside of academia, whilst maintaining the rigor, detail, and quality that benefits the common pursuit to create new knowledge for the benefit of the continent.

3. Bank, W. (2014). *Uganda Industrial Research Institute: Uganda Case Study* (World Bank: Other Papers). World Bank.

The lack of cohesion between stated goals and desires of those receiving science education, those who stand to benefit, and those who are working to encourage it, ultimately sabotages the collective ownership of an agenda that can unlock the potential innovations of Africa. African national academies of science have an opportunity to change this, to work together for continental benefit by working across disciplines to understand perceptions, political dimensions, and the science itself regarding science education and human development.

Science Development and Manpower Development in North Africa: Successes, Challenges, and Prospects

Sameh Soror
Head, Biochemistry and Molecular Biology Department,
Helwan University, Egypt

Algeria, Egypt, Morocco, and Tunisia all ranked low in the WEF 2017-2018 competitiveness report in the areas of quality of science and mathematics ranking, staff training at higher education ranking, quality of primary education ranking, and quality of secondary and tertiary
education system. They also score below the Organization for Economic Co-operation and Development (OECD) average according to the 2015 Programme for International Student Assessment (PISA) report.

Challenges faced in North Africa include:

- A mismatch in the curricula and job skills requirement.
- Curricula not being able to develop professional and entrepreneurial skills.
- Weak linkages between the academia and industry.
- Political instability in some regions, limiting reform agenda.
- Low numbers of scientists in active research compared to the total number of staff in these institutions.
- Losing talent to emigration (brain drain).
- Fifty percent (50%) of the population is at education age thus increasing the demand and cost of education, particularly secondary and tertiary education.
- STEM schools are being introduced but there is a wide gap between their existence and the demand for them.

Current Initiatives

Egypt has come up with an initiative called the Children University. The idea is to change the traditional way of science education, develop children's creativity and innovation ability, and attract them to the study of science. Thirty-one universities all over Egypt (public and private) are participating in this initiative, reaching out to a total of 11,000 school students between the ages of 9 and 16 years.

Another national project in Egypt is Zewail City; Egypt's national project for science renaissance. The objectives of the City are to prepare a new generation of students capable of thinking critically and creatively, mastering basic sciences, linking academia and industry, building entrepreneurship, and delivering outcomes that have a significant impact on society and economics. The City comprises of a high school, technical pyramid, Centre for Strategic Studies, research institutes, and a University of Science and Technology which are all interconnected and linked, as well as boasts of a diverse faculty, state of the art undergraduate laboratories, the latest teaching technology, and the involvement of various research institutes. Academic excellence (above 93% in Physics, Chemistry, Biology, and Math, as well as English proficiency) are the only criteria for admission into Zewail City. The faculty at Zewail City include universities in the USA and Canada.

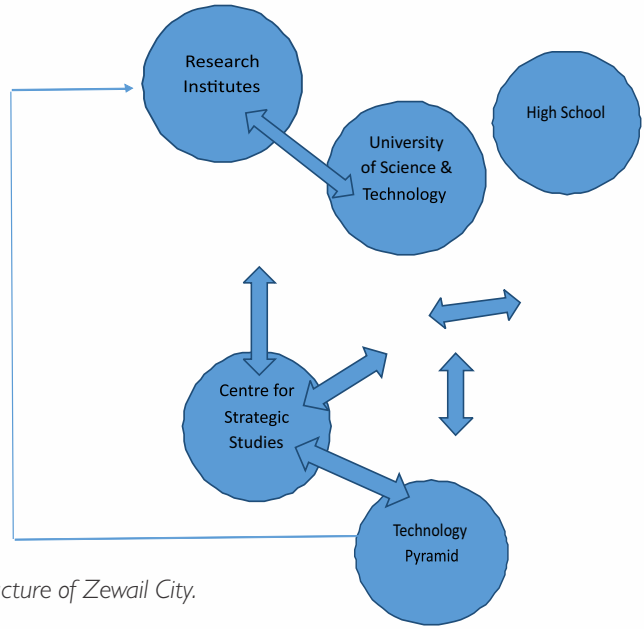

Figure 1: Structure of Zewail City.

Prospects of improving education in North Africa involves:

- Reform plans for science education and STI which is currently on-going in the region.
- Curricula modification that must be able to cope with a knowledge-based economy.
- A need to find ways to mobilize resources without compromising equity and quality of education.

Discussion

1. Quality of Education

- There are not enough primary and secondary schools in the region providing basic standard science education in comparison to the tertiary institutions. Emphasis should be placed on primary and secondary education.
- There should be an educational reform in every African country/sub-region in the establishment of quality institutions, and minimum standards and training requirements for teachers at all levels. Teachers need to be the best in their fields in order to get science promoted amongst the students. Academies of science should push for this.
- The establishment of more research universities that will focus on the development of science.
- Communication in terms of the language of teaching in each country is important. The language of teaching has to be reviewed because though English language is the common lingua franca globally, children are known to do better when things are explained to them in their mother tongue.

2. Linking Science to Industry

- Centres of excellence are good avenues to promote science education and to promote collaboration between the academia and industry. Continued collaboration between the two should be encouraged, as this is key to promoting science education.
- It is essential to "seed" the industry as this will in turn back-up the educational sector. Thus, the industry needs to be provided with relevant research and innovation from the laboratories. Scientists need to move out of the laboratories and into the communities, working on research that can change communities and drive GDP growth.

3. Politics and Education

- In almost every African nation, different policies have been passed at different times which have not favoured the educational sector resulting in large numbers of public schools throughout the region that are ill-equipped to provide the basic form of quality education.

Political will cannot be over-emphasized as where the foundation is weak, the solutions are far-fetched. Countries should consider having national champions that will drive science promotion. These champions should be high-powered individuals in the form of past presidents, members of parliaments etc. that can drive and promote the agenda of science in each country.

4. The Role of Academies of Science

- Students and communities in countries in our region need to benefit more from the academies of science. The fellows need to engage more with the students and the community to drive the message of the importance of science in national development. Some form of public enlightenment is necessary, and should be on the annual agenda of academies as a way of giving back to their societies.
- Fellows of academies need to mentor students; particularly primary and post-primary to further drive home the message of the importance of science and its relevance to our modern-day society.

Session 2: STI and Sustainable Development in Africa

Building Partnerships for Sustainable Development

Yao Ydo

Director, UNESCO Regional Office, Abuja

"To successfully implement the 2030 Agenda for Sustainable Development, we must swiftly move from commitments to actions. To do that, we need strong and inclusive partnerships at all levels"
-BanKi-moon, Former Secretary General, United Nations

Sustainable development must meet the needs of the present without compromising the ability of future generations to meet their own needs. Four dimensions of sustainable development are economic development, social inclusion, environmental sustainability, and good governance.

Building partnerships for sustainable development should be voluntary and collaborative with all participants involved agreeing to work together to achieve a common purpose, to share risks and responsibilities, resources, and benefits. Sharing responsibilities will involve co-creation, shared risks, interdependency, and organizational transformation. It is critical that the partnerships emphasize transformation (which is strategic and integrative) more than transaction (which is more commercial/philanthropic), so as to achieve the scale and level of impact required to catalyze substantial achievement of the SDGs.

Critical factors for effective partnerships will include:

- Establishing the need for partnerships; setting a clear case for partnerships.
- Due diligence partners.
- Building and maintaining trust.
- Setting out clear vision of objectives, roles, and responsibilities.
- Investing the time in people and resources to manage the relationship
- Accountability.
- Sustainable exit strategy.

UNESCO, together with its partners, assists member states in Africa in the creation and enhancement of conducive environments for STI for sustainable development, particularly by:

- Strengthening the science, policy and society interface to advance equity and social inclusion.
- Strengthening human and institutional capacity for education and training, as well as research and innovation in science and engineering.
- Promoting South-South, North-South, and triangular partnerships to enhance joint education and training, research and innovation, exchange of experts, and international peer reviews.
- Supporting career mentoring and development of innovation hubs and networks with emphasis on empowering women in science and engineering, and enabling the creation of an entrepreneurial culture.
- Providing foresight planning to STI governance and policy, assisting African member states in the review and formulation of their national STI policy using UNESCO's STI mapping and analysis instrument, the Global Observatory of Science, Technology and Innovation Policy Instruments (GOaSPIN).

UNESCO believes that African academies can play a vital role in STI development on the continent. To make this happen, academies need to work together to ensure that scientific research results can be used to transform the lives of people, particularly in the rural areas. The academies should also work with their countries to take advantage of partnership opportunities to strengthen their STI systems and STEM education. African academies should take the lead in documenting scientific information from research breakthroughs and experts, and share this information to create visibility, which will in-turn attract the buy-in of partners.

Significance of Basic Sciences in the Socio-economic Development of Africa

Godwin K.S Aflakpui
Dean, Faculty of Applied Sciences, Methodist University College Ghana/ Ghana Academy of Arts & Sciences (GAAS)

The basic sciences (mathematics, physics, chemistry and biology) are the building blocks for applied sciences. Scientists all around the world, who have made significant strides in socio-economic development, have had their innovation based on research from the basic sciences.

The wide range of discoveries (from the theories of optics to his ground-breaking work on the laws of motion and gravity) by the English mathematician and physicist, Sir Isaac Newton, were the blueprints of modern physics.
Svante Arrhenius, the Nobel Prize winner in Chemistry, was the first to give an indication of the existence of climate change, which the science community described as obsolete but is now a worldwide phenomenon. Louis Pasteur, the French chemist and microbiologist who is one of the most important founders of medical microbiology, developed the remarkable breakthrough in the causes and prevention of diseases, one which has laid the foundation for medicines still in use to this day.

Challenges facing the teaching and learning of basic sciences in Africa include a lack of interest by students in the secondary schools, who would rather opt for elective arts and business subjects; inadequate teachers who are sometimes also poorly skilled; inadequate facilities to teach the basics of sciences in the schools; a generally poor performance in mathematics and science; and most importantly, a lack of political will to commit the necessary funding needed to revitalize the basic sciences. Initiatives like the Alliance for Accelerating Excellence in Science in Africa (AAESA) launched by the African Academy of Science (AAS) should be encouraged and duplicated.

Recommendations to change the state of things include:

- Training a critical mass of teachers in the basic sciences.
- Equipping the laboratories with up to date equipment.
- Investing at least 2% of GDP to science.
- Establishing more mentorship programmes and scholarship schemes.

Leading Integrated Research for Agenda(LIRA) 2030 in Africa Programme

Jackie Olang-Kado
Executive Director, Network of African Science Academies (NASAC)

LIRA 2030 is a five-year (January 2016-December 2020) programme aimed at strengthening integrated research capacity for sustainability in Africa. It is implemented by the International Council for Science (ICSU), together with its Regional Office for Africa, NASAC, and the International Social Science Council (ISSC), with financial support from the Swedish International Development Cooperation Agency (SIDA).

LIRA's objectives are to:

- Increase the production and use of integrated (inter and trans disciplinary) solutions–oriented knowledge in Africa.
- Build a technology-driven community of practice in the region.
- Foster African scientific leadership for the implementation of the Agenda 2030 and its SDGs.
- Foster collaborative research in Africa and the participation of African scientists in the implementation of global research programmes such as Future Earth, Integrated Research on Disaster Risk (IRDR), urban health, and well being.
- Mobilize institutional and financial support for integrated research and capacity building in Africa.

LIRA is for early career scientists with no more than 10 years' work experience following their PhDs or equivalent research experience. There is also a preference for female scientists and other scientists from low income countries. Thematic focus is in the context of African cities through the lens of gender equity and poverty reduction, and includes:

- Global environmental change.
- Disaster risk reduction.
- Health and human well-being.
- Sustainable energy.

LIRA is governed by a scientific advisory committee that defines the programme's scientific strategy, advises on further development, and makes research funding decisions based on

African cities through the lens of gender equity and poverty reduction, and includes:

- Global environmental change.
- Disaster risk reduction.
- Health and human well-being.
- Sustainable energy.

LIRA is governed by a scientific advisory committee that defines the programme's scientific strategy, advises on further development, and makes research funding decisions based on the review of research proposals. Expected outcomes include creating a network of about 30 projects across Africa, a technology-driven community of practice, place-based knowledge, increased support for integrated research, and learning from knowledge co-design and co-production for sustainable urban development in Africa.

Discussion

1. **Developing Partnerships**

- It is apparent that many countries on the continent are facing similar challenges in the area of STI and manpower development. It is therefore necessary that regional collaboration takes place to proffer solutions to these issues.
- Regional organizations such as the African Development Bank (AfDB) need to invest more in home-grown research.
- In order for the SDGs to be achievable, they need to circulate beyond the intellectuals, and translate into transformational tools that are relatable to all people. A guide needs to be developed for academies on how they can get involved in the SDGs.
- Academies of science need to engage and partner more with academies of social sciences. More collaboration will encourage a more holistic development of nations in the region.
- The younger generation of researchers should look into the archives of old research and try to build on past research work that show promise; identify the issues/challenges of the research; and create interventional strategies to solve them and bring about development.
- African scientists in the diaspora should develop partnerships with home-based scientists; nurturing our own partnerships and marrying wealth of experience from around the world together with local knowledge and expertise to bring about national development.

2. **LIRA 2030 Programme**

- Life is multi-faceted and complex. Thus, one of the objectives of LIRA is to contextualize relevant research and make science useful from the research.
- LIRA seeks to celebrate and encourage our own African scientists
- Some African governments do not acknowledge the existence of

slums, and rather focus on the urban areas. Disregarding these slums means disregarding their associated challenges such as those discussed in the on-going LIRA projects on power and communicable diseases. Acknowledging their existence will bring more focus and possible solutions to the communities and their antecedent problems.

Session 3: Safeguarding Africa's Scientific Future Through STI Education Especially of Women and Young Scientists

Panel Discussion

Discussants: *Lead remarks: Himla Soodyall – General Secretary, ASSAf*
Jonathan Ayertey – Council Member, Ghana Academy of Arts and Sciences (GAAS)
Tope Olomola – President, Nigerian Young Academy (NYA)
Dominic Makawiti- Vice-President, Kenya National Academy of Sciences (KNAS)
Phyllis Kalele – Senior Liaison Officer, ASSAf

Lead Remarks

There are almost always several activities on-going regionally in the science world at every point in time, by the many players within the science disciplines. While this is laudable, considering the fact that it is keeping science alive, it is critical to look into what the overall impact of these activities are on national development. Scientists need to become more strategic in the various approaches to science so as to have better outcomes.

It is important to sustain investments in young scientists, particularly now that the young scientists are growing in an era that is driven by technological advancement and tools. These young scientists are the next generation of players that will contribute to the shaping of our continent-our future. Science in this generation has a wider variety of disciplines than was available years ago, creating an overlap of disciplines. This should be taken as a strength and used to the advantage of national development. *In this case, many cooks do not spoil the broth.* Existing networks that promote activities of young scientists include young academies of science, the Global Young Academy, and even social media.

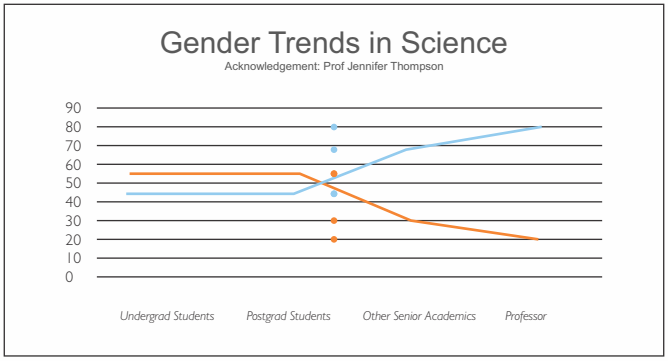

Figure 2: Gender Trends in Science

Figure 2 brings to life the dearth of female scientists. There needs to be more of an affirmative action in female education to reverse this trend. Initiatives such as having a bias towards women admissions into science institutions, and debunking the age-long myth of females not being able to study sciences should be instituted. Mentorship among women scientists should also be encouraged, and equal opportunities, particularly for positions of authority, should be made available to both genders. Male academics should also be encouraged to nominate their female counterparts into deserving positions of authority.

The Organization for Women in Science for the Developing World (OWSD) is a non-profit, non-governmental, independent body founded in 1987. It is the first international forum to unite eminent women scientists from the developing and developed world, with the objective of strengthening their roles in the development process and promoting their representation in scientific and technological leadership. The OWSD has representation from Africa, Latin America and Caribbean, Asia and the Pacific, and the Arab countries, with Africa having the largest membership of 2792 women. The membership of OWSD comprises of OWSD members, mentors, fellowship holders, and award winners. The three guiding principles of OWSD are adaptation, relevance, and communication.

- In ensuring the development of young minds from an early age, children should be taught science in a more practical and applicable way; learning from nature and interaction, which will lead to better understanding. Promising young scientists should be poached from universities of science and technology. Unfortunately, in many nations on our continent, these institutions are under-funded and under-resourced. Universities, in many cases, have become more focused in generating funds by increasing student numbers without an equivalent increase in training resources.

- It is clear that STI is going to drive the economies and development of the next century. A pertinent question to ask is, 'is Africa making the necessary preparation to develop the scientists that will drive this?' Countries already have in place a plan and strategy to train, develop, and, if necessary, import the manpower necessary to drive STI for their national development. The strategic plans for Singapore and Malaysia, for example, have factored in them the number of PhDs needed and by when.

- Mentoring is also very important; role models are dwindling across the continent; thus, Academies fellows should be more engaged in the mentoring of young children. They should organize and participate in annual or bi-annual science fairs to foster an early interest in science. Science-based clubs and applications should also be created and, where already available, promoted. The technology space that has captured the minds of the younger generation should be taken advantage of. Centres of excellence should be created around the continent where the direct correlation between investments in STI and national development can be nurtured and developed.

Discussion

1. Early science development

- In ensuring the development of young minds from an early age, children should be taught science in a more practical and applicable way; learning from nature and interaction, which will lead to better understanding. Promising young scientists should be poached from universities of science and technology. Unfortunately, in many nations on our continent, these institutions are under-funded and under-resourced. These universities, in many cases, have become more focused in generating funds by increasing student numbers without an equivalent increase in training resources.
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2. Mentorship

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Session 4: Securing Investments for Science

Panel Discussion

Discussants: *Lead remarks: Umar Bindir - Secretary to the State Government (SSG), Adamawa State*
Asifa Nanyaro - Executive Director, Tanzania Academy of Sciences (TAAS)
Suad Suleiman – Treasurer, Sudanese National Academy of Science (SNAS)
Vincent Tanya – Director of Research, Cameroon Academy of Sciences (CAS)

Lead Remarks

Most countries use their resources to take care of their people and use scientific means to sustain this. Unfortunately, Africans most times use up intellectual capacity to conquer issues of poverty, and believe that solving this problem shows the ability to solve all other issues on the continent. This is not enough to move the continent forward; science must be able to provide solutions that demonstrate value for money and, ultimately, demonstrate return on investment (ROI).

For a long time, the developed nations have been able to demonstrate ROI, investing heavily in well-equipped institutions that are doing well and highly ranked. These institutions achieve this by being globally and technologically visible, as well as having a wide range of products available world-wide. The developing nations in Asia are following closely behind by following the steps of other developed nations, and are now achieving global visibility and world-wide product ranges. Sadly, many of the countries in Africa fall under the category of nations who have failed to adapt, show low productivity, little visibility, and little or no ROI. African countries have failed to fully understand the theories and practices of STI, without which securing investments in science will be difficult.

Scientists are highly intellectual people, who dig deep into things and are able to explain how things work. The main outputs of scientists are knowledge, expertise, and specialization.

Engineers and technologists understand the language of the scientists and transform these into practical solutions to problems. Engineering proves the science of things, and technology shows that these things are useful. The product of technology is intellectual property (IP). Africans need to protect their IP which when turned into an asset is known as technology transfer (TT). The TT process opens up innovation where all players (with or without any expertise) can develop commercial products and services that cause development.

Using Nigeria as a case study of a typical African nation, Nigeria has negligible global products, and is not technologically visible globally, despite the presence of a strong academy of science.

Nigerian leaders have constantly challenged the science communities with their political policies. For example, the green revolution tasked the scientists to come up with ways products can survive on little water/rain and sustainably feed the people. Unfortunately, till date, there is no report showing how this project fared. Nigeria has what it takes to take up the policy challenges of the leadership; with its knowledge infrastructure from about 154 institutes of higher learning - the academics, knowledge in biotechnology, renewable energy etc. However, all this knowledge needs to be transferred into solutions.

Currently the realities in Nigeria show science producing poor ROI, with over 70% of Nigerians living with poor basic infrastructure. Farming, one of the largest employers of labour in the country is still mainly practiced using basic tools, with most of the technological advancements in this area, not accessible to most farmers. Nigeria is failing to train the younger generation in the culture of using scientific solutions to innovate and create value/money, to develop a culture that links the knowledge system and development. The continuous importation of technology into the country does not provide justification for investments in our own scientific community.

The solution for Nigeria and African countries lies in deliberately turning things around; being creative and functionalizing the knowledge system.

Academia needs to be transformed by changing institutions from schools into centres that produce scientists, technologists, and innovators; centres of excellence that translate the policies from leadership into quantitative knowledge, and transforming universities into enterprises that are able to sell their products and IP for their self-sustenance. Africa needs to get to the point where researchers are part of the presidential advisory teams that accompany the presidency on visits to developed and developing countries where intellectual partnerships can be formed.

Discussion

1. **Innovative sources of funding for STI development in Africa include:**

- Government: African nations should honour the Lagos Plan of Action (AU 2006) to dedicate at least 1% of GDP in funding R&D. Till date, most countries are yet to comply.

- Domestic taxes should be instituted, at appropriate tax rate per GDP, to fund development, research, and social services.

- Private sector: countries need to provide an enabling environment to encourage private sector investments in R& D.

- Attract overseas R&D investments: diaspora can be attracted to invest in technology companies and bring in new technology and competitive skills.

- Endowment funds &philanthropy: Engage the wealthy Africans to make endowments that will be used for research.

2. **Government and Private sector issues**

- So far in Africa, government is still the main source of funding of research and this is grossly inadequate. There needs to be a n increase in knowledge transfer from the universities; this is one-way research institutes can be self-suffieient.

- The researchers need to prove their relevance to the various governments and the private sector, with the academies ensuring synergy among the multiple players. The academies are influential and well respected in every country and should leverage on this to ensure synergy among the multiple players and steer the discuss in using science and technology for national development. The academies should have the ears of their country presidents.

- There needs to be increased and better collaboration between the research institutes and the private sector. Researchers need to be better communicators and prove the value of their research to the private investors, as the private investors need to see value and ROI. The academies can play a major role in this regard; for instance, a committee can be set up to come up with strategies for better collaboration between scientists and the private sector. The committee should be a mix of researchers and industrialists. A platform needs to be created; an incentive framework for the private sector that will cause them to seek out the researchers to know how their research can benefit the companies and the larger society.

- Researchers need to ask for what they need from the government and private sector and make good cases for the requests. Good proposals need to be written, forwarded to appropriate sectors, and followed up aggressively.

- Research institutes need to look inwards to produce internally generated revenue (IGR) from their products and intellectual property. This will bring in the much-needed funding.

Also, it is important for researchers to understand the environment that they work in making requests the same way as in the last 20-30 years will be unproductive. Thus, it is important to look at the environment and data available and change things. Researchers must find new ways to tell their story; to show the link between their research and development; improving livelihoods for a better future.

Session 5: Building the Science-Policy Nexus in Africa

Panel Discussion

Discussants: *Lead remarks: Jonathan Fanton – President, American Academy of Arts and Sciences (AAAS)*
Peter Onwualu FAS – African University of Science and Technology (AUST)
Yousuf Maudarbocus – Vice President, Policy Review and Administration, NASAC
Robin Crewe – Co-Chair, Inter-Academy Partnership for Research (IAP-R) Harnessing Science, Engineering and Medicine (SEM) for Africa Project
Declan Okpalaeke – Editor at Large/Head, West Africa Operations, The Conversation Africa

Lead Remarks:
Connecting Science to Policy: Insights from the U.S and Africa

The MacArthur Foundation works in over 50 countries and maintains four offices around the world, including Nigeria. The MacArthur foundation has been making grants in Nigeria since 1989 and has supported work in the field of higher education, reproductive health, and population. Some of the grants include

- Upgrading teaching laboratories at the Ahmadu Bello University.
- Establishing a gas and turbine institute in Port Harcourt.
- Establishing an African Regional Centre for Information Science at the University of Ibadan.

The Foundation also played a major role in supporting research for policy development in reducing maternal mortality in Nigeria. Research conducted by the Population Council was to improve the availability and use of Magnesium Sulphate in the management and treatment of pre-eclampsia, as well as training health workers in its use.

This led to a 40% decrease in maternal mortality in the ten test centres where it was implemented. The success of this research led to a collaboration between the Population Council and other NGOs in training programmes in over 70% of nursing and midwifery schools in Nigeria, as well as the Federal Ministry of Health's adoption of the use of Magnesium Sulphate in the management of pre-eclampsia in health facilities nationwide.

The AAAS was established in 1780 and has its headquarters in Cambridge, Massachusetts, with a membership of 4900 fellows and 600 foreign honourary members. It is devoted to the advancement and study of the current key societal, scientific, and intellectual issues, and hopes to improve its connections with science institutes and universities around Africa. The messages coming out of the AMASA-13 meeting align with the AAAS 2014 report brief on Restoring the Foundation: The vital role of research in preserving the American dream which reiterates that the decisions that policy makers and leaders in science, engineering, and technology of any nation make will determine the trajectory of that nation's innovation.[4]

The main recommendations from the report on America's future in innovation also rings true in other regions and focus on three overarching objectives:

- Securing sustainable government investment in research particularly in basic research.
- The people receive the maximum benefits of government-funded research.
- Establishing a more robust partnership among government, industry, and university.

There is need for the government to put more focus on investments in basic research which, though may take many years to materialize, is more likely to result in path-breaking discoveries. For example, the existence of the widely popular iPhone was made possible by federally-funded basic research.

[4]Report Brief Restoring the Foundation: The Vital Role of Research in Preserving the American Dream.

Figure 3: Federally Funded Basic Research Made the iPhone Possible (Photo courtesy AAAS)

Discussion

1. Government-University-Industry

- An environment has to be created to drive STI to any level required. There needs to be a push for the creation of a think-tank that will drive the implementation of science into policy.
- Thus far, the impact of policy documents from the science institutions and academies have been limited. There is therefore the need to put proper structures in place to encourage the necessary discussions.
- The membership of African academies should be more inclusive and involve those who have distinguished themselves in the industry and government.

  That way, natural links are established and collaboration becomes easier. For example, a third of the members of the US Academy are from industry.
- Africa can take a cue from countries like China for example who in trying to create stronger links among university and industry have developed a community model which starts from the building of industrial parks, followed by the establishment of university departments related to the industry-type on the park, then student hostels/dormitories and finally, companies. The idea is that students from the departments will have work experience/ internship in the industrial parks during their studentship and having their hostels in close proximity to the park brings about easy accessibility. Companies who then have their companies in the park can then recruit/employ these students on completion of their studies with an added advantage that these students have some industry experience.
- Regional Economic Communities (RECs) can also be used to bridge the gap between science and policy.

2. Communication

- The media needs to be brought into the science and policy nexus for a greater impact. Often times, the public and policy makers find it difficult to understand the language of the scientists. The media can help to bridge this gap through science reporting. Reporters/science journalists can work together with scientists to simplify the work into language that the public and policy makers can understand and identify with.

Conclusion

Key points highlighted during the presentations and discussions include the following:

1. Academies need to take on the task of bridging the gap between science and industry by creating a platform for collaboration and cooperation between them for the increased use of scientific research in the development and strengthening of economies.

2. Academies can set up 'Think Tank' committees comprising of Academy fellows and industrialists, whose mandate will be to find ways for fruitful collaboration between the academies and the private sector.

3. African academies should be more inclusive in their membership. Members of the private sector and industry who have distinguished themselves in their fields of expertise should be considered as Fellows. This will also ensure a sustainable relationship/connection between science and industry.

4. Fellows of African academies should be more involved in the mentoring of the younger generation to encourage the furtherance of science. This mentorship should not be limited to the tertiary level, but also include the secondary school students. Initiatives such as annual science fairs should be promoted by the academies.

5. African nations should consider having high powered individuals serve as 'champions of science' for their countries. These people will help drive and promote the science agenda of that country.

6. Universities need to create and nurture the relationship between science and industry by providing industry with relevant research and innovation.

7. Education reform is necessary in many of the African nations. The reform needs to focus more on science education at the primary and secondary level, as well as on increased training of science teachers.

8. It is apparent that many African countries face similar challenges in the area of science and manpower development. Thus, regional collaboration among countries should be encouraged and nurtured for the collective development of the continent.

Appendix

Participants List

SN	NAME	AFFILIATION
1.	A. Galadanchi	Nigerian Communications Satellite Limited (NIGCOMSAT)
2.	A. P. Onwualu FAS	AUST Abuja
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69.	Jonathan Fanton	AAAS
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88.	Nicholas Ibeh	NAS
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