

**Roundtable on Inquiry-Based Science Education**  
**&**  
**Forum on “The Future of Science Education – Challenges and Opportunities”**

16-17 April 2013

Khartoum, Sudan

Organized by ISTIC (International Science, Technology and Innovation Centre for South-South cooperation under the auspices of UNESCO) and The Future University

With the support of the Federal and State Ministries of Sudan and TWAS

# ***HIGHLIGHTS***

## Introduction

For the second time, ISTIC (International Science, Technology and Innovation Centre for South-South cooperation under the auspices of UNESCO) and the Future University jointly organized a workshop on “IBSE for Science Educators from African Countries”, supported by the Federal and State Ministries of Sudan and TWAS from 14-18 April 2013, Khartoum, Sudan. The workshop aimed to promote Inquiry-Based Science Education (IBSE) methods of teaching. Both the Federal and State Ministries of Education selected teachers and teacher trainers from across Sudan to participate in the event. They joined international trainees from countries such as South Africa, Cape Verde, Kenya and Egypt and ISTIC-selected trainers from Malaysia and the Philippines to learn new techniques in IBSE methods and take these back to their respective educational institutions. The programme lasted for five days. In conjunction with the Workshop, Future University and ISTIC organized a Roundtable and Forum on 16-17 April 2013.

During the opening session of the **Roundtable on Inquiry-Based Science Education**, following an introduction by Prof. El Tayeb Mustafa, President of The Future University, Dato Ir Dr. Lee Yee Cheong in his address highlighted the strong collaboration between Sudan and Malaysia noting that this was the first ISTIC-organized workshop outside Malaysia. He underlined a number of ISTIC’s objectives including capacity building in human –resource development in science and technology and innovation in developing countries, and the need to convince countries, especially Islamic countries, to encourage women participation in STI. He also noted the need to maintain and increase centres of excellence, noting examples in Nigeria, Tanzania and Kenya, to encourage good research projects reaching the markets. He conveyed ISTIC’s gratitude to TWAS for the joint publication of case studies of “Innovations in Science and Technology in Developing Countries” in 2012.

He referred to the IAP’s flagship programme on science education, and in particular IBSE-related activities, led by IAP Member Academies. He noted the need for scientists and engineers to work with social scientists and historians to make sure IBSE is multi-stakeholder owned, also by addressing gender issues and engaging young people. One of the challenges of IBSE is to pursue the push for a critical mindset in young people.

The Minister of General Education in Sudan, Souad Abdel Razek, in her keynote address underlined that the organization of this event was a milestone of collaboration for Sudan, both bilateral and other. She mentioned that there are 17,000 basic schools in Sudan, 40,000 secondary schools which means 7 million children are at primary and secondary school.

500,000 are due to sit their final exams shortly and of these a very limited number are taking science subjects. She noted this is her greatest challenge, also as first female Minister of Education, to encourage children to adopt a good attitude and skills for the future. She underlined the commitment of the Sudanese Government and other ministers to change the situation in the country. Building confidence of children and making science easier, through adoption of new methods, can help. A new set of experts and partners, for instance ISTIC and The Future University, are already contributing to children's education in Sudan, thus making Sudan a starting point for the rest of Africa. There is a need now to change the dimension: visit communities and develop resources on how science can make the environment healthier.

Prof. M. Hassan, IAP Co-Chair, in introducing the speaker, Prof. Bruce Alberts, highlighted some of his main attributes, including his pioneering work in the field of biochemistry and biophysics; his strong commitment to engage academies of science across the globe to make them more active and more useful to society, and his efforts during his Presidency at US NAS, to launch the ASADI initiative funded by the Bill and Melinda Gates Foundation for the benefit of Academies of Science in Africa. Throughout his career Prof. Alberts has maintained a personal passion to improve science education at a global level through problem-solving methods.

Prof. B. Alberts in his presentation encouraged Sudan with the support of the Ministry of Education to prove to be a model for other countries to follow suit. He informed on the status of science education in the US and that one of the major problems continues to be how science is taught at college. He underlined that business and industry are looking more and more for people who can solve problems, and "think for a living". There is therefore a need to develop science understanding and abilities using examples such as the PISA Assessment and Analytical Framework (OECD) which asks questions such as: Are students well prepared to meet the challenges of the future? Can they analyse, reason and communicate their ideas effectively? Have they found the kinds of interests they can pursue throughout their lives as productive members of the economy and society?

He noted a number of resources including the US NAS guide on scientific practices; special issues in *Science* on Science Education, including most recent one on "Grand Challenges in Science Education" which includes 24 examples of Prizes in the SPORE contest; the Science Prize for Online Resources in Education (SPORE) - established to encourage innovation and excellence in education, as well as to encourage the use of high-quality on-line resources by students, teachers, and the public. Reference was also made to Jacob Bronowski's Book on *Science and Human Values* – a set of thought-provoking essays on science as an integral part of the culture of our age.

Prof. M. Hassan, in his presentation on IAP and its role in promoting global science education outlined the objectives of the global network of science academies and in particular the strengths of national academies and functions of an active Academy. He mentioned also the growth in the number of national science academies in Africa. He highlighted the work of the global science education programme, with the dedication and leadership of scientists including Prof. Yves Quéré, Prof. Jorge Allende, Prof. Pierre Léna and the functions of the global council for the Science Education Programme. He proposed that academies consider building science centres of excellence as part of their mandate in order to create global partnerships in IBSE. A number of successful groups already exist in Africa, eg. ASTC (Association of Science-Technology Centers), Networks of Universities (eg. IAU and AAU) and Academy networks (eg. IAP, and its regional network NASAC).

Prof. Yves Quéré, Académie de Sciences, France, in his presentation on the global outreach of the IBSE/LAMAP activities, illustrated a number of very simple scientific experiments he had witnessed in Togo, which engaged the children. He made reference to the founder of La main à la pâte movement, Prof. Georges Charpak, adding that there is a strong link between science and history, between natural science and mathematics, and between science and music. He conveyed his thanks to one of the pioneers of the IBSE methods, Prof. Wei Yu, former Vice Minister of Education, China, for her strong support in implementing IBSE schemes in China.

Prof. Romain Murenzi, TWAS Executive Director, in his speech on “Global Science Education in the South and the Role of TWAS” underlined that science education that should be on the agenda of every country’s government that is interested in building or strengthening the foundation of a long and sustained development. A nation’s “science education” must be formulated as part a national science, technology, and innovation (STI) policy which has four objectives of which science education is the foundation: Knowledge acquisition and deepening; Knowledge creation; Knowledge transfer; Innovation.

He added that it is widely recognized that science and technology are keys to development – both in developed and developing countries, and the main scientific challenges of our time include climate change, energy security, food security, disease, clean water and population growth. He stressed that global academies like TWAS, regional and global networks of science academies such as NASAC and IAP, can coordinate or facilitate efforts to meet these challenges.

Ms. Jackie Olang, NASAC Programmes Director, in her presentation on science education in Africa and the role of NASAC highlighted the mammoth task for such a huge continent, and the need to promote the establishment of national science academies in Africa, currently 17 of which are NASAC Members to work with society and the governments. NASAC’s role is to facilitate, through support from IAP, capacity building of national science academies. Countries

such as Rwanda, Benin, Namibia and Togo are currently addressing the establishment of a national science academy and need support. NASAC Members had implemented a number of IBSE-related activities, partially funded by IAP, including science education for girls.

Ms. Joanna Lacey, IAP Secretariat, was invited to provide further information on IAP and informed on the priorities of the recently issued IAP Strategic Plan III, which includes “Championing Science Education”, the results of the Rio-2013 Conference to drive a “Grand Challenge on science literacy”, and the strengthening of the global science education programme. She noted that national science academies are encouraged to apply for funding of activities through the annual call for projects/proposals.

Prof. Mohamed Al Tom, Fellow of the Sudanese National Academy of Sciences (SNAS), referred to science education in Sudan and the need for reform within the school system, and underlined the Academy’s commitment, with the input for the Sudanese Academy of Young Scientists (SAYS) in promoting the teaching of science in schools.

Prof. Maged Al Sherbiny, President of the Academy of Scientific Research and Technology, (ASRT) Egypt, highlighted a number of mobile “Fab Labs” now functioning in Egypt. Fab Lab Egypt is an Egyptian NGO which promotes innovation and creativity among students now involving 48,000 schools with a plan to extend fabrication labs all over Egypt targeting schools and university students together with young entrepreneurs. He added that the recently founded Egyptian Young Academy is taking science education experiments forward also through the Global Young Academy (GYA) membership. Science Museums have also proved to be an important investment for a country for both students and schools, as are science books and grassroot innovations (eg. Tok Tok transportation). The ASRT is keen to engage with SNAS and other academies in Africa to develop joint projects.

Professor Mohamed Belaiche of the Hassan II Academy of Sciences and Technology in Morocco outlined developments for a national young academy in Morocco and recent activities organized by the Academy, including regional contests of innovation, implementation of La main à la pâte methods in schools and colleges, in close collaboration with the Académie des Sciences, France, resulting in a gradual increase from 28% to 35% of orientation towards science subjects.

Dr. Ismail Abdelhamid, Sciences Directorate, ISESCO (Islamic Educational, Scientific and Cultural Organization) noted the need to encourage the promotion of science education through ISESCO

Member States, currently numbering 51, which can reach out to a very high number of researchers.

Prof. R. Murenzi added that the Head of the Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science (AAAS), Dr. Shirley Malcolm, following the successful implementation of joint workshops on IBSE in collaboration with TWAS and IAP, is ready to support and collaborate with initiatives emerging from the discussions.

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**The Forum on “The Future of Science Education – Challenges and Opportunities”** on 17 April 2013, was organized in the form of a Davos-Style Panel, moderated by Dr. Bruce Alberts, Editor-in-Chief, *Science*, with the participation of Dr. Adnan Badran, Former Prime Minister of Jordan, Prof. Yves Quéré, Member and Foreign Secretary of the French Academy of Sciences and former IAP Co-Chair, Dr. Alec Boksenberg, Professor of Astronomy, University College London, Dr. Dato Ir. Lee Yee Cheong, Chairman of the Governing Board of the International Science, Technology and Innovation Centre for South-South Cooperation with an introduction by Prof. Mohamed Hassan, IAP Co-Chair.

The discussions, with interaction from the audience which included teachers, teacher trainers, and students, produced very useful results both for Sudan and for the developing world as a whole. It was seen that education is a “hot” topic in many countries and it was noted that there is a strong need for change from facts (memorization) to active science, and scientific experiments to build curiosity in students. Science education is vital for peace and primary education needs basic science well integrated into the curricula: resources and investment is needed from governments along with a national science policy. Science is a basic human right for human dignity and a good understanding of sciences builds respect and can help prevent extreme situations such as genocide.

A number of additional points emerged, summarized below:

In order to build a strong science curricula in state schools the engagement of the Ministries of Education is paramount – this was also underlined by the presence of H.E. Minister of General Education, Souad Abdel Razek during the Round Table, where it was emphasized that taking children to private schools does not divert the Ministry’s attention but rather increases the disparity for good education in state school systems.

The importance of IAP's flagship programme in science education is considered a top priority by the majority of national science academies, including science literacy. IAP's Science Education Programme (SEP) Council will meet on the occasion of the ISTICs 5th Anniversary at the International Conference in Kuala Lumpur 22-24 May 2013 on "ISTIC: A Role Model for South-South Cooperation through STI" to discuss future plans for the IAP global programme.

The interest and support of UNESCO was underlined by the presence in Khartoum and support of former UNESCO Directors/Special Advisors including Prof. M. El Tayeb, Dr. A. Badran, and Dr. A. Boksenberg, as well as a number of UNESCO representatives in the audience.

The presence of H.E. Irina Bokova, UNESCO Director General at the opening of the above ISTIC Conference in Kuala Lumpur will also provide the opportunity to engage further with UNESCO which - as a governing body with Member States - can connect Ministries of Education to Academies and vice versa for increased and strengthened linkages. As there is a need to identify ways to get UNESCO buy-in and ownership of IBSE methods in science education, an initial start could be with the Ministries of Education in developing countries to address science and maths curricula in primary and secondary schools.

It also emerged that there is a need to concentrate on the teachers. E-learning, and discussion-group methods, whereby the teacher is part of group interacting at the same level as the students, need to be encouraged and strengthened in schools. How science is taught is vital. Science is a universal culture – stretching across the globe and science teaching requires preparation and knowledge. Teachers are needed at an early age for training in science education at primary level in order to build the leadership of a country.

Why and how to teach science to children is one point, but another point emerged which is the dignity linked to the public understanding of science, the dignity to know. Science consists of looking at the world and contemplation. If science is taught to children from an early age, it opens their minds to contemplation.

High-level scientific institutions are then needed to keep the students working in the fields and to allow for partnerships across the globe to build confidence, and national growth.

In discussions concerning the quality of education, one problem which is arising in many countries, including Sudan, is the tendency to place children in private schools, especially where parents are professionals and country leaders. This diverts the Ministry of Education's attention by placing too much funding into improved private facilities which damages investment in state education and creates an unfair system.

The situation in Sudan is not uncommon from other parts of Africa. State/Government schools in the 50's and 60's were the best schools but the level has since dropped. South Korea had a similar problem and re-organized the state schools system over a period of ten years which is now bearing fruits.

In Jordan the problem also exists where 30% of children are in private education. These schools also attract the best teachers. This is encouraging two societies leading to potential areas for conflict. Leading universities and companies tend to select the elite students from the private schools to build future leadership in that country. Governments need incentives to address the issue.

In Sudan there have been attempts to develop e-learning courses at The Future University. Plans are currently underway to develop interactive programmes and courses with MIT (Massachusetts Institute of Technology). Open-access sites in Sudan are often blocked due to sanctions. Many teachers are doing lessons on-line but a combination with active learning is necessary. Technology is now having a big impact on the younger generation. Students are often distracted by I-phones and high-tech devices and are unable to concentrate on learning science as there is not enough interest in older methodologies. The teaching of science needs to be fun. Questions were raised on what age a child should start to study science, and what are the most effective approaches, i.e. balancing basic facts using experiments with scientific findings and scientific methodologies

There is also a shortage of literate people in rural areas of Sudan. Mention was made of working with families, who can directly benefit, if children are encouraged to stay at school. Teachers also serve as a bridge in this process and NGOs and the private sector should be encouraged to invest in technology platforms in schools. NGOs need more government support to revise policies and change the environment, and more interaction is needed with the media to communicate to the public to encourage indigeneous education.

Another general problem which emerged is that the teaching of physics, chemistry and maths is not being given enough attention. Medicine, pharmacy and applied science tend to be more popular but it was underlined that basic science is vital in order to know "WHY".

Research facilities for basic sciences are also diminishing and teachers are not often valued in these topics. There is a high tech revolution which distracts people away from going into real science. The issue is not how much you spend on science and education but that the attitude and environment also need addressing.

Learning the history of science – and the contributions of great scientists and great philosophers should also be encouraged. Younger students should be aware of their peers. Science is a subject of truth. Not only does the history of science provide us with a technical framework but it also conveys to us a humane background where culture is important.

It is important to look at the civilisations of the past and the ways they lived in tune with nature. A number of examples were mentioned including the “Smart Green Civilization” series which ISTIC plans to promote, also in Sudan, in particular on climate change, together with the local production of solar energy through a solar lantern, to enable children in remote areas of the country to be able to read.

The Rwanda experience shows that science education is a condition for morality and peace. Science education is not sufficient to avoid conflict but IBSE methods can build ethics in science and encourage curiosity. Parents therefore also have a role and can stimulate science education from birth – by encouraging curiosity in their children from an early age.

## **Conclusion**

It emerged from the discussions that education is a complicated business. Students must be at the centre and if they are not learning there is a need to find out why. There is often a resistance to change and the introduction of new ideas so workshops for educators from different countries should be encouraged to get a balanced view. “Excellence” in primary schools must remain at the forefront with the need to stimulate competition to do well.

The participants with the inputs of the students and teacher trainers agreed that there is no perfect formula for education but that one of the most important things is to build critical thinking and critical minds – be open to innovation and new ideas, be curious and ambitious and build on examples of innovative young scientists around the world.

## References

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### **Follow up action points:**

1. Continue to promote IBSE through key players (ISTIC, La main à la pâte, IAP and its Member Academies, IAP Regional Networks of Academies)
2. Encourage Academies, through IAP, to support the building/strengthening of “science centres of excellence” as part of their mandate to promote IBSE and create global partnerships.
3. Provide support in particular to Academies of Science in Africa through NASAC/IAP Capacity building programmes, to address the need for reform of state of science in schools, and promote the teaching of science.
4. Seek buy-in from UNESCO - through Member States, to approach the Ministries of Education, with support and involvement of national science academies (IAP network)
5. Develop school curricula to empower students and equip them with skills to build attitudes with inquiry-minds.
6. Use examples of success stories of IBSE method including those implemented in Malaysia, Singapore, Taiwan China, China, Japan and Finland.
7. Start science teaching early: Concentrate on ethics and behavior.
8. Take into account the power of modern communication tools
9. Pursue recommendations from the IAP Conference in Rio 2013 to address a “grand challenge” in science literacy and an IAP Statement on Science Education.
10. Encourage Young Scientists in Sudan (through nominations submitted by SNAS, SAYS and GYA) for the Summer Davos Class 2013 (deadline 24 May 2013)
11. Maintain close contact with the Coordinator and Council of IAP’s Science Education Programme Global Coordinator, to discuss next steps, including outcomes of the ISTIC Council Meeting in K-L in May 2013, preparations for the Global SEP Conference in China in June 2014, and future IAP Secretariat support to Council.
12. Engage, through the Sudanese Academy of Sciences (SNAS), with the Minister of General Education, H.E. Souad Abdel Razek - to provide policy advice for the science curricula. (The Minister had also underlined her strong interest in building science curricula in Sudan during a private meeting with Prof. R. Murenzi).

13. Follow up the visit to the Sudanese National Academy of Sciences (SNAS) with Prof. R. Murenzi, Ms. Jackie Olang, NASAC Programmes Director, and IAP Co-Chairs also through face-to-face meetings with Ms. Olang in Trieste (10 June 2013).
14. Consider ways to support to SNAS and build its capacity in particular by encouraging:
  - a pattern of seminars and public lectures.
  - English versions of the scientific publications for school/university students.
  - the strengthening of the SNAS Secretariat.
  - joint seminars/workshops between Academies of Ethiopia and Sudan.
  - workshops in particular on science education drawing on the experience and outcomes of the Future University/ISTIC Roundtable on IBSE with the presence of the Minister of Education.
  - future joint projects between SNAS and the Ethiopian Academy of Sciences on, also in line with outcomes of first EAS/SNAS project sponsored by IAP on “Model-based approach to Science Education”
  - linkages with USAID in Khartoum to reach out to society.
15. Consider IAP-funding opportunities through online call for proposals (to be issued in 2013) for new projects in line with IAPs 6 Strategic Priorities, especially focusing on “Championing Science Education”
16. Follow up proposal by Prof. Bruce Alberts on possible ways to highlight scientific experiments on the IAP website using examples illustrated by Prof. Yves Quéré, and by requesting IAP Members to participate.

19 June 2013