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la science et la culture



The Republic of Uganda

Uganda National Commission for UNESCO



REPORT ON THE POPULARISATION OF SCIENCES USING CHAMPION TEACHERS

DECEMBER 2017



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Popularization of Science Using Champion Teachers.

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Cover Photo: Group photograph of Participants after the workshop.

PREFACE

According to its Medium Term Framework (2014-2022), UNESCO will firstly provide policy advice on science, technology and innovation (STI) and strengthening of STI capacities, and secondly enhance international scientific cooperation for advancing inclusive sustainable development, exercise leadership in ocean and fresh water issues and develop holistic solutions to climate change adaptation and disaster risk reduction. This is meant to strategically bridge the multiple gaps between science, policy and society by mobilizing and supporting multidisciplinary scientific knowledge to inform decision-making and promote the ethical, social, environmental and economic aspects of sustainable development. It is important to note that UNESCO's Director General is the host for a Scientific Advisory Board to advise UN Secretary General and the UN system on how to use science to advance the goals of sustainable development and strengthen the science-policy society interface within the context of the SDGs. UNESCO promotes the practice of integrated science for sustainable development, or sustainability science which draws on the full range of scientific, traditional and indigenous knowledge in a transdisciplinary way to address economic, environmental, ethical and societal challenges. With its category 1 institutes and extensive networks of affiliated scientific institutes and category 2 centres, UNITWIN networks and UNESCO Chairs, the Organization is particularly well placed to facilitate the efforts being made with respect to technology transfer.

The sciences form the basis for understanding and analysis of human and natural systems. In this regard, the community of scientists ought to be the engine for generating practical solutions to many of the challenges in the world. Engineering is a vitally important contributor to economic development and job creation, particularly for the youth and this calls for capacity building in engineering and the other science disciplines for advancing sustainable development. Thus, the appalling situation of low popularity and dismal performance in the Natural Sciences at the Secondary School level in Uganda in the midst of high unemployment and declining growth indicators is of great concern and worry and calls for a special attention focused on understanding the problems facing the interest, learning and teaching of the Sciences in Uganda's Secondary Schools. This initiative by the Uganda National Commission for UNESCO is an effort to experiment the use of teachers as champions in popularizing the Sciences with a view of generating interest that can boost the performance in the schools countrywide.

I recommend this report for wider dissemination to share some of the preliminary clues here on which more can be built for improving the situation of Sciences and Mathematics in Uganda.



Rosie Agoi
SECRETARY GENERAL

Acknowledgements

The Uganda National Commission for UNESCO wishes to acknowledge the support from the Government of Uganda through the Ministry of Education and Sports for funding this workshop. We wish to thank the Chairperson for the Interim Board of the National Commission, Prof. Eriabu Lugujjo for his participation and passionate appeal for support to students specializing in sciences and retention of science teachers especially those specializing in the physical sciences and mathematics as these category of teachers are very rare and not found in most of the Schools.

Gratitude is also due to the Acting Commissioner Secondary Education, Mr Benson Baritazale Kule for his appeal to the teachers for creativity and the advice to the Government against making the sciences optional in Ordinary Level. A special tribute to the external facilitators namely Ms Joyce Awor Ebal from the Uganda National Examinations Board (UNEB) and Mr. James Asile Droti from the National Curriculum Development Centre (NCDC) for awakening the teachers to examination, curriculum and pedagogical issues. The Officials from the Uganda Secondary Science and Mathematics (SESEMAT) played key roles in guiding the debates during the discussions.

We would also like to thank all the teachers for their participation in the workshop and providing some insights into the issues surrounding the plight of Science and Mathematics in the Schools they represented. The workshop would not have been possible without the leadership at the Uganda National Commission headed by the Secretary General, Ms. Rosie Agoi, the planning and execution by the Programme Officer, Dr. Dominic Venture Mundrugo-Ogo Lali and the supporting staff especially the Personal Secretary to the Secretary General, Ms Ruthi Kalema and the rapporteur/Intern, Mr. Vincent Ogal. To all of these Officials, the National Commission for UNESCO is very grateful.

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LIST OF ACCRONYMS

IN-SET: In service Training of Teachers

CPD: Continued Professional Development

NCDC: National Curriculum Development Centre

SDGs: Sustainable Development Goals

SESEMAT: Secondary Science and Mathematics

STI: Science, Technology and Innovations

STEI: Science, Technology, Engineering and Innovations

UNATCOM: Uganda National Commission for UNESCO

UNEB: Uganda National Examinations Board

UNESCO: United Nations Educational, Scientific and Cultural Organisation

UNITWIN: University Twinning and Networking Programme as UNESCO Chairs

UNSG SAB: United Nations Secretary General's Science Advisory Board

1.0. BACKGROUND

According to the report released on 5 October 2016, the UN Secretary-General's Scientific Advisory Board (UNSG SAB) called upon scientists and policy-makers alike to promote a set of principles that underpin the crucial role of science for sustainable development, namely to:

- **Recognize science as a universal public good** that helps to lay the foundation for a sustainable world and is therefore more than a tool for the achievement of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs).
- **Acknowledge basic science as a principal requirement for innovation** and provide a productive scientific environment, including long-term investments, to advance fundamental knowledge about the world.
- **Enhance diversity in science for sustainable development** by realizing gender equity in science and by building on the entire spectrum of society, including underrepresented groups and minorities.
- **Strengthen science education** to increase science literacy and capacity-building in science at all levels.
- **Raise investments in science** by establishing national minimum target investments for science, technology and innovation for both basic and applied science.
- **Promote an integrated scientific approach** addressing the social, economic and environmental dimensions of sustainable development and respecting the diversity of knowledge systems.

The UNSG SAB accordingly recommended to the UN Secretary-General and the international community, including the scientific community, to maximize the contribution of science beyond being a 'means of implementation' with regard to achieving the 2030 Agenda and the SDGs through the following actions:

1. Consider the 2030 Agenda for new research and integrate the SDGs into research agendas at all levels.
2. Anchor science as a reliable partner in the implementation and review process and thereby enhance the science-policy interface.
3. Establish independent scientific monitoring mechanisms and promote evidence-based decision-making for sustainable development.

In addition to the voluntary, state-based review process, the scientific community should simultaneously and independently monitor progress and evaluate success towards achieving the 2030 Agenda and the SDGs.

The Uganda Government has for the last three decades advocated for the prioritization of science, technology and innovation as the main basis for development. To actualize this plan, the government made the teaching and learning of science subjects compulsory in lower secondary schools in 2004 (Daily Monitor, June 4th and 25th 2015). The government also developed the National Science Technology and Innovation (STI) policy in 2009 to provide the framework for promoting science and technology in the Country. According to the NDP 2010/11-2014/15, the economy of Uganda is built around four sectors namely primary growth sectors, complementary sectors, social sectors and enabling sectors. The primary growth sectors consist of sectors and sub-sectors that directly produce goods and services. These include: agriculture, forestry, manufacturing, tourism, mining, oil and gas, ICT and housing development. It is important to note that all the components of the above listed primary growth sectors are rooted in science and mathematics which are the elements of natural sciences.

The Natural Science is UNESCO's second major programme and UNESCO believes Science must respond to societal needs and global challenges through improved public understanding of, and citizen participation in science. UNESCO has been rewarding and giving recognition to outstanding research in areas such as environmental conservation, biosphere reserve management, fresh water, health and life sciences, prizes for young scientists, women in science and for the popularization of science, but sadly, there have either been no nominations or awardees from Uganda for these awards over the recent past decade. Moreover, there are currently increasing concerns about the continued low popularity of science and mathematics in the minds of students and hence students' continued poor performance in these subjects in the national examinations.

What is the Problem?

According to the reports from the Uganda National Examinations Board (UNEB), the trend in performance over the period of 2010, 2011 and 2012, has shown consistent 40% annual failure of students in ordinary level Mathematics, Physics, Chemistry and Biology. Comparison of those three years showed worsening trends in failure rates. The report indicated failure rates of 75.6% in Chemistry in 2012 compared to 71.1% in 2011 and that even of those who passed; majority did so marginally without credits (Daily Monitor June 4th, 2015). The report quoted the then Executive Secretary, UNEB lamenting that only 20% of the total candidates who sat in 2014 offered Mathematics, 14.4% offered Physics, 11.5% offered Biology at advanced level, of which majority did not get principal level pass required for progression to further specialized studies in Universities and other higher institutions of learning. A report released by the Monitor Newspaper on 25th June 2015 further reported that girls performed worse than boys with 75.6%

of female candidates scoring F9 in Chemistry compared to 66.7% boys who also scored F9. At Ordinary Level in 2011, 71.1% of girl's failed Chemistry compared to 63.4% boys and 52.9% girls failed compared to 47.8% of boys in 2010. In Physics, 66.7% of girls failed in 2011 and 66.9% failed in 2012. In Biology, 46.6% of girls failed in 2012 up from 44.5% in 2011 (Daily Monitor June 25th, 2015). Hence despite the sciences being compulsory at O-level, enrolment and performance in natural science subjects has not improved. Of the total number of candidates registered in 2016, only 14.5% (about 15,500) pursued science combinations – 20% offered Mathematics; 14.4% sat Physics; 11.5% sat Chemistry while 12.3% offered Biology. The former Minister of Education while releasing the 2015 results in 2016 had lamented about the persistent high failure rates in the sciences despite slight improvement in Physics, Chemistry and Mathematics that year. She attributed some slim improvement in sciences to compulsory Information and Communication Technology (ICT) teaching at O-level as well as the reduction of combinations from four to three subjects, which she said had offered learners "ample time to concentrate on their selected subjects". She had tasked the technical staff at the ministry to establish why fewer learners were opting for sciences despite all students sitting for the subjects at O-level. She also criticized school heads for insisting that learners who want to offer science combinations should have scored distinctions at O-level. "A student who obtains a credit [at O-level] should be allowed to offer sciences at UACE in all schools," she directed.

As for ICT, there was reported improvement in enrolment as Subsidiary subject since its introduction in 2013, from 65,688 candidates in 2013 to 69,431 in 2014. About 81% scored at least a point in the subject compared to 72% in 2013. The percentage also increased in 2014. The Daily Monitor report of 4th June 2015 identified the problems with sciences as poor methods of teaching lessons and girls studying in mixed schools, lack of critical thinking and negative attitude of learners to natural sciences.

1.1. The Rationale and Context of the Workshop and the Concept of Champion Teachers

It is against this background that there is need to examine the multiplicity of factors at play in Uganda's School system. It is possible that as reported elsewhere that early practical involvement of children in scientific experimentation, encouragement of independent thinking, hard work, and positive mindset, deliberate encouragement of young learners by teachers and parents towards the natural sciences, the self-motivation of learners, availability and nature of facilities or materials for practical experiments and career counselling could make the turning point. Special consideration given to gender inequality reflected in terms of enrolment for UACE in 2016 showing that girls constituted 43,944 (about 40%) of the total number of candidates with the assessment body (UNEB) despite more females opting for nursing, teaching and vocational programmes after their Uganda Certificate of Education in the previous year of 2014 would attract sufficient curiosity given the trend of female candidates generally excelling in arts

subjects. One approach that has not been emphasized is that of deliberate popularization by recruitment of champions. In this case, using people who would instigate “**Magical Turnarounds**” in what has previously languished or under-performed. Teachers who would make it their concern to address those subjects or topics that others have worked at espoused as their cause or at the least had responsibility for overseeing without good success. Teachers who would be called effective champions by stimulating interest of students and dramatically improving their performance as a result of their unique dedication and commitment to work for better results. Hence, the rationale for convening of this workshop.

1.2. Objectives of the Project

Overall Objective:

To promote the popularization of Natural Sciences for Sustainable Development Using Teachers as Champions.

Specific Objectives

1. To document and share existing policy issues regarding the teaching and learning of sciences
2. To document and debate the performance of students in the learning of science subjects
3. To share and evaluate the problems on the various schools affecting the teaching and learning of the sciences
4. To share information on the performance of the students from primary level to the senior secondary classes
5. To discuss the structures, governance and gender concerns regarding the teaching and learning of natural sciences in schools

Expected Outputs

- 1) Relevant policies on the teaching and learning of natural sciences documented and shared
- 2) The relationship between learners’ performance and teaching of the subjects documented and shared
- 3) Information on the existing structures, governance and gender concerns regarding the teaching, learning and the choice of natural sciences in the various selected schools shared
- 4) Practical recommendations and action points for natural science champions made to address the gaps in the points 1-5 above

1.3. Targeted Participants

The teachers targeted are teachers of natural science subjects from mixture of schools that have been performing excellently and poorly in the subjects, according to the records from UNEB. The selection was a mix of secondary schools of private and public ownership, rural, urban, mixed and single sex, boarding and day schools and the teachers on the SESEMAT Programme. In total, 60 schools were sampled consisting of 15 from each region made up of at least a proportionate mixture of poorly and best performing schools and the other criteria defined above.

1.4. Methodology

The workshop was organized in close consultation with the management of the SESEMAT Programme, the Uganda National Examinations Board (UNEB) and the National Curriculum Development Centre (NCDC). It brought together representatives from all the regions of Uganda. The methods of the workshop included: brainstorming, presentations by selected experts and by each participant, discussions of the presentations, group work and plenary sessions.

The report of the issues from the Schools was captured to form the basis for further analysis and sharing with the relevant officials of the Ministry of Education and Sports prior to dissemination meeting to be organized in due course.

1.5. Expectation of the Participating Teachers

The following were some of the expectation from the participants of the workshop.

- i. Conclusive solution to poor performance of students in regard to science subjects and mathematics.
- ii. Challenges from school and cause of poor performance.
- iii. New approach to teaching of science.
- iv. How to improve on teaching of science and mathematics.
- v. New methodologies in the teaching of science from different schools.
- vi. Expectation of certificate of attendance.
- vii. Expectation that the program for the workshop would be followed.
- viii. Proposal that the old methods of making sciences and mathematics be readopted.
- ix. Comparing challenges existing in different schools.
- x. To see all methods making presentations from the different schools present.
- xi. Sharing experiences.
- xii. Coming up with a way forward on the implementation and improvement of sciences and mathematic performances.

2.0. OPENING REMARKS

2.1. The Secretary General, Uganda National Commission for UNESCO

The Secretary General represented by the Programme Officer for Sciences, Dr. Dominic Mundrugo-Ogo Lali welcomed all of participants to the workshop and thanked them for honouring the invitation. He informed them that the workshop had been organized to share the ideas on the best ways possible in improving the performance in Sciences at the Secondary level and improvement of enrolment of learners for careers in the Natural Sciences. He called it popularization and defined "popularization" as carrying one of two meanings: the spread of knowledge in science and technology to the masses or the acquisition of new science and technology for improving one's social and economic life. He explained that popularization is therefore important as it should lead to raising awareness, inculcating scientific spirit and eliciting vocations to scientific study and career. He informed the participants that this undertaking was in line with UNESCO's Natural Sciences sector whose current theme is 'Science for Peace and Sustainable Development' and Strategic Objective of strengthening science, technology and innovation systems and policies and promoting international scientific cooperation on critical challenges to sustainable development. He explained that UNESCO is a specialized agency of the United Nations founded in 1946 to contribute to the construction of peace, human development and dialogue through education, the sciences, culture, communication and information. He further elaborated that UNESCO's contribution to world peace and development is based on its five functions: Laboratory of ideas and foresight, Standard setter, Clearing house, Capacity-building and as Catalyst of International cooperation.

The Secretary General further listed UNESCO's four (4) fields of competence as Education, Science, Culture and Communication & Information and said that these fields of competence are programmed into five (5) namely: Education, Natural Sciences, Social and Human Sciences, Culture and; Communication and Information. He informed the participants that there are National Commissions for UNESCO (NATCOMs) that serve as the interface of UNESCO with Member States at the national level and hence it is the NATCOM that assist government Ministries, Departments, Agencies, Institutions, Individuals, Community Based Organizations, and NGOs in developing their plans and projects in line with the UNESCO's guidelines and programme framework. UNATCOM promotes the understanding of the objects and purposes of UNESCO among the people of Uganda, advises government on matters of UNESCO and plays all those roles that are necessary for implementation of the programmes and activities in accordance with UNESCO standards and guidelines, recommendations and international conventions in all UNESCO's areas of competence.

He concluded by thanking all the participants for turning up for the workshop and urged them to all to pay very close attention and make the necessary contributions including recommendations for taking the initiative the forward. He then invited the Chief Guest, the Chairman of the UNATCOM Interim Board to make his remarks and officially open the workshop. (Full text in Annex II)



Dr. Dominic Lali Mundrugo-Ogo, the Programme Officer for Sciences delivering speech on behalf of the Secretary General of the Uganda National Commission for UNESCO (UNATCOM)

2.2. Remarks from the Chairman UNATCOM Interim Board

The Chairman of the UNATCOM Interim Board, Prof. Eriabu Lugujo as the Chief Guest welcomed the participants to the workshop. He urged the participants to recognize that international organizations, and in particular the UN Agencies have made deliberate efforts to encourage African States to take Science and Mathematics very seriously in the development agendas. He said that Uganda in its quest to improve its capacity in Science and Mathematics has come up with a number of Strategic Policy documents such as: The White paper, The STI Policy, The BTVET Act, Skilling Uganda, and more recently The Uganda Vision 2040. He explained that Uganda's Vision 2040 is to achieve a "Transformed Ugandan Society from a Peasant to a Modern and Prosperous Society (Country) within 30 years". One of the paths to achieve the above transformation is to strengthen the country's capacity in Science and Technology, Engineering and Innovation (STEI). According to him, Uganda has good policies but they are poorly implemented. Optimal implementation is premised on a set of necessary and sufficient conditions like policy analysis, availability of adequate, accurate and timely information and a policy marketing system that enables all actors to understand the policy and resources to implement the policy, wider stakeholder participation, consensus, cooperation, commitment and ownership of the policy by most policy actors. An adequate marketing of the policies is therefore a very important process.

The Chairman then posed a question: "How did we get where we are in Science and Mathematics despite the good policies?" In answering this question, he explained that successful countries in STEI system follow an atomic model where human resource constitutes the nucleus around which everything revolves.

On the issue of good teaching, he said that: "Teachers teach the way they were taught and trained". A teacher must have an absolutely solid grounding in the subject content. He explained that there are some personal elements that also matter and some of these are:

- Hands-on tailor-made skills (like knowing your students - empathy)
- Open-mindedness (in and out of class)
- Demonstrative Stimulating approach and commitment
- Creative - Inspiring – Systematic innovativeness

He commended the workshop as a positive move in the right direction, because it would discuss how champion teachers would succeed where others have failed. He wondered how one would explain the fact that 820 candidates got zero in mathematics in 2016. He requested the participants to analyze the reasons for this decline: whether it is the curriculum, pedagogy or it is because students are getting submerged in the sea of globalised variables?

He concluded by encouraging the participants not to despair but resolve for solutions to this multidimensional problem. He lauded the programme for the workshop as reflective enough to

produce feasible recommendations and finally, thanking all for listening and praying for God's guidance to all, declared the workshop open.



The Chairman, UNATCOM Board, Prof. Eriab Lugujo, addressing the participants at the opening of the workshop.

2.3. Remarks from the Commissioner for Secondary Education

The Acting Commissioner Secondary Education, Mr. Benson Baritazale Kule in his remarks thanked professor Lugujo for the informative presentation which was clearly in the form of a problem statement in the field of science that requires solution. He reiterated the Government policy of compulsory science education in Ordinary Level (O-level) and this is in recognition that science is a public good. He argued that since O-level is a basic education level, every subject being taught at this level is basic meant to provide general knowledge to students. He condemned the move to make sciences optional in Ordinary level as suicidal and should be avoided because the knowledge gained is very important in life, providing solution to cross cutting issues. He advised that Information and Communication Technology (ICT) should be used as an enabler to further assist in the delivery of resources on sciences as opposed to being considered as alternate to subsidiary Mathematics which he stated was very important and should be made compulsory at Advanced Level (A-Level). He informed the workshop that, much as there are shortages of infrastructures in schools, the government through the Ministry of Education has been able to construct 290 science laboratories countrywide adding the number to 5,813, and 3.9 million text books had been distributed to schools. He noted that these are however not being utilized by some of the schools as expected. He also noted that the SESEMAT programme was designed to work as summer fora where teachers of science subjects come together to devise new means of delivering resources to students.

The Commissioner urged the teachers to always carry out practical sessions at the end of every topic to enable students best understand concepts and new ideas. He directed that the practice of conducting practicals only towards the end of Senior Four (S4) be stopped with immediate effect. He urged teachers to always plan for field works as part of the lessons to improve students practical learning. He also advised all teachers to avoid relying on external examinations but should rather set their own examinations to assess students' progress. For the slow learners, he advised teachers to organize remedial classes to bring them on board but that should not be in form of coaching.

He concluded by assuring the teachers that the Ministry is doing everything to mainstream science education in the entire curriculum.



The Ag. Commissioner, Secondary Education, Mr. Benson B. Kule addressing the participants as the UNATCOM Board Chairman, Prof. Lugujo looks on.

2.4. Reactions by the Participants to the Commissioner's Presentation

- i. A teacher from Kaabong District disputed the availability of Laboratory facilities saying that teachers regularly fight for opportunity to conduct practical lessons in the school because of the struggle to use the only Laboratory space in the school and especially when the teachers fail to agree on who should have the priority to use the Laboratory. This is a challenge of inadequate infrastructure in Kaabong District schools.

In response, the Commissioner advised the school to make use of mobile laboratories or classrooms in the meantime.

- ii. A teacher from Buliisa informed the Commissioner that there was no Biology teacher on the government payroll in their School.

In response, the Commissioner advised that the love for their children should guide them to continue teaching because the School Facilitation Grant used for paying the teachers

who are not yet on the government payroll is still being provided for by the government. The government is currently recruiting teachers at a ratio of 3:1 for Sciences and Arts respectively and it will help in the long run to bridge the gap.

- iii. A teacher from Biguli secondary school, Kamwenge District informed the workshop that their School was a beneficiary of World Bank project but the only laboratory being constructed was still incomplete and so not of any use to support learning in Science.

In response, the Commissioner informed the workshop that the Government through the Ministry of Education currently has so many pending projects and the little available resources was being prioritized.

- iv. One teacher wanted more information on Special Funding or Loan Schemes for further studies in the field of Physical Sciences for teachers with interest in progressing in academics.

In response, the Commissioner advised that for now, they should try to save money and avoid spending money on surplus belongings while being always on the lookout for potential scholarships.

- v. On the question of “What a good school must be like”, the Commissioner stated that a good School is that which produces students with good moral character, good work habits and ethics.

2.5. Recommendations

At the end of the above interactions, the workshop participants adopted the following recommendations:

- 1) Government should revisit the White Paper on Education (The Kajubi Report) which had proposed that the Science teachers stay within their profession by benefitting from the various ladders of promotion. The recommended motivation packages for retention should also be implemented.
- 2) Government should also urgently consider motivating Science teachers by providing various avenues and opportunities for them to go for further studies in the various Science disciplines.
- 3) Teachers should adopt the use of simpler languages and localize concepts in a manner that can easily be absorbed and understood by students and teachers alike so as to help in the long run in bridging the learning gap.

3.0. PRESENTATION OF PAPERS BY SPECIALISTS

3.1. The Causes of Poor Performance in Science and Mathematics at Secondary Level

By Joyce Awor Ebal (Ag. Principal Examinations Officer – Uganda National Examinations Board (UNEB))

Ms. Joyce Ebal, the Acting Principal Examinations Officer in her paper said that the main objective of the paper was to highlight the causes of poor performance of students in science and mathematics as reflected in the candidates work at the national examinations. She elaborated that scientific knowledge is acquired through the testing of facts and by making observations and describing mechanisms of systems, natural phenomena, and presenting explanations to their occurrences with logical conclusions from experimental work.

Elaborating on UNEB's mandate, the Examinations Officer explained that the Uganda National Examination Board (UNEB) is mandated by the UNEB Act of 1983 to among others conduct secondary school examinations. UNEB designs test items based on the specific objectives of the Teaching syllabus developed by National Curriculum Development centre (NCDC) (2008 for UCE and 2013 for UACE). She said that UNEB assumes that by the end of a circle, candidates would have been taught all that is specified in the teaching syllabus and therefore have the required knowledge and skills. She then gave the grade boundaries set by UNEB in judging students performance at Uganda Certificate of Education examinations (UCE) are

- Distinctions Up to 2
- Credit Up to 6
- Pass Up to 8

The Official further explained that a high percentage of students attaining the distinction level would imply an excellent performance, while at credit six would be fair and pass eight marginal pass. On the other hand, poor performance would be when a high percentage of students fail to obtain the minimum pass grade of eight. She informed participants that at the Uganda Advanced Certificate of Education (UACE) examinations, a student is considered to have passed a subject when he/ she obtains a minimum of a subsidiary pass "O", although for a student to be offered that subject or courses related to the subject at tertiary institutions, a minimum of principal- E-pass would be required. Therefore, when a high percentage of candidates fail to meet this minimum standard of principal pass-E-, then performance is regarded as being poor.

On the causes of poor performance, she cited the report from examiners as indicating various causes of failure in sciences. These include the lack of basic scientific and mathematical knowledge like definition of scientific terms, units of measurement and simple mathematical

operations like addition, subtraction, multiplication and division resulting to zero score. Also noted was the inability of candidates to understand questions, inability to apply theory or knowledge to real life situations, inability to present data in the appropriate form and interpret it for example as graphs, lack of practical experience leading to inability to manipulate laboratory equipments and reading correct measurements while performing experiments in practical examinations, inability to correctly use geometrical instruments in mathematics and inability to make detailed observations together with logical conclusions. Another cause cited was the inability of candidates to correctly describe experiments when required in a theory examination.

She then presented a Performance Table is as shown in the Annex III.

Concluding Remarks

In her conclusion, the UNEB Official stressed the importance of science in today's world saying it has brought in rapid development in almost all fields including engineering, medicine, computer science, Business, management etc. that has greatly transformed the world. She said that the acquisition of appropriate scientific and technological skills is therefore necessary for a developing country like Uganda to cope with this growing challenge and appealed to teachers to work hard and improve the weaknesses cited in the report as the major causes of failure of candidates. She concluded by calling upon the teachers to participate in the in-service training for science and mathematics teachers through SESSEMAT.



Ms Joyce Ebal from UNEB (standing left) listening to questions from a participant (standing right with an arm stretched in gesture)



A Cross-section of the participants attending the workshop and one participant (standing near window) raising issues for discussion.



Participants contributing to discussions during one of the plenary sessions

3.2. Curriculum Interpretation and Pedagogy in Science and Mathematics Education

By Droti Asile James (MSc-Chem; BEd.; PGDCDD; Dip. Educ.) Curriculum Specialist-Chemistry

The Specialist began by defining curriculum as the knowledge and practices in subject matter areas that teachers teach and that students are supposed to learn while Pedagogy is the science and art of education, specifically instructional theory. He explained that a curriculum generally consists of a scope, or breadth of content, in a given subject area and of a sequence of concepts and activities for learning and Standards typically outline the goals of learning, specifying the materials, tasks, and discussions, representations - to be used to achieve those goals. Teachers are expected to implement the curriculum to achieve the intended goals set by interpreting it correctly. He noted that there is great public concern about declining performance of students in science and mathematics over the years since 2005. He informed the participants that the Government had put different interventions in place: science kits, new laboratories, Continued Professional Development (CPD) for science and Mathematics teachers (SESMAT), etc..

As to whether curriculum interpretation affects student performance, learning outcomes and achievement, Mr. Droti, answered in the affirmative and explained that to a greater extent, it does affect the student's performance. He said curriculum interpretation involves identifying the scope, or breadth of content, in a given subject area and the sequence of concepts and activities for learning to take place. It also involves identifying the appropriate strategies to be used to deliver the curriculum, the evidences of achievement of the learning outcomes and the resources to be used for effective learning. He said that good curriculum interpretation results in a good lesson plan and hence enhancing learning of students. He illustrated as below:

- ▶ Content – Identifying Important Content
- ▶ Understanding – Developing Student Understanding
- ▶ Environment – Creating a Positive Learning Environment
- ▶ Assessment – to improve student's learning (FOR & OF)

He concluded that the pedagogy for conceptual, procedural and Nature of Science learning in science education could be more effective if the curriculum is restructured in the perspective of students' learning and how their ideas might develop rather than being that of standard science. He made a number of recommended for teachers and curriculum designers including rethinking of approaches and mentorship in teaching and re-thinking in curriculum (See Annex IV).

3.3. UNESCO's Strategy on Science Promotion

By Dr. D.V. Mundrugo-Ogo Lali, Programme Officer, Natural Sciences, Uganda National Commission for UNESCO

The Programme Officer informed the participants that UNESCO is the only UN technical agency charged with promoting and overseeing the developments in Science and technology in the whole world. He spelled out UNESCO's strategy as aimed hinged on the promotion of science, technology and innovations within the Member States and encouraging increased investments to promote technological advancements. The commonest strategies include awards, prizes or scholarship schemes some of which are listed below:

- i. UNESCO Kalinga Prize for Popularization of Science
- ii. UNESCO L'Oreal Prize and Fellowship for Women in Science
- iii. UNESCO-Equatorial Guinea international Prize for Research in the Life Science
- iv. Avicenna Prize
- v. UNESCO Science Prize (Under Review)
- vi. UNESCO/Institute Pasteur Medal
- vii. UNESCO Albert Einstein Award
- viii. UNESCO Sultan Qaboos Prize for Environmental Preservation
- ix. Carlos J. Finlay UNESCO Prize for Microbiology
- x. UNESCO Young MAB Scientists Award
- xi. Michel Batisse Award for Biosphere Reserve Management
- xii. Mercosur Science and Technology Award
- xiii. UNESCO Medals for Contributions to the Development of Nanoscience and Nanotechnologies
- xiv. UNESCO Niels Bohr Gold Medal
- xv. The Young Scientists and Women Prizes / Scholarships: For youth of 18 to 45 years who developed innovative ideas that can be supported.

3.4. The General Qualities and Key Characteristics of Champions

By Dr. D.V. Lali Mundrugo-Ogo, Programme Officer, Natural Sciences, Uganda National Commission for UNESCO

The Programme Officer presented a list of qualities that champions should have. These include: always striving for success, being creative people or innovative, being endlessly inquisitive, having self-discipline and courage, rising up after every failure, not motivated by selfish interests only, not being just a winner, but person of compassion, humanity and motivated by a sense of obligation to others as strong as the will to succeed for them. He noted that the result of a champion's work is seen in "magical turnarounds". Things should seem to have "magically" improved when they previously languished or under-performed.

Quoting one Author, Ari Weinzweig (2006)¹, he listed some key elements that distinguish a Champion from others and makes them effective. These include being visionary, possessing a vision that inspires others raising their eyes from preoccupation with problems to a vision of opportunity, from concern with weakness to exploitation of strengths, having a great passion for what they're working on, being passionate and enthusiastic about new and more effective methods of teaching that makes students love the subject which, ultimately, contribute to better performance, being always on the move, having fun and getting those around them pumped up, getting things done, not waiting around, not reckless or with some manic sense of misplaced urgency, not wasting huge amounts of energy, being positive and affirmative about work, taking constructive advantage of resources that others seem to ignore, promoting teamwork, they appreciate the contributions of those around them, and joke in the face of adversity. Their co-workers respond to that positive energy, not giving up due to criticism, overcoming inertia by keeping things moving, taking responsibility for results, being organized, paying attention to details of successes and weaknesses, applying "user-friendly" ways that inspire those around them to be ever more diligent to detail and their involvement in work improves service, staff morale and everyone wins.

¹ Ari Weinzweig (2006): Fifteen Characteristics of effective Champions. Zingtrain.com

3.5. Reflections on the theme: Guidelines in the Popularization of science and technology

By Dr. D.V. Lali Mundrugo-Ogo, Programme Officer, Natural Sciences, Uganda National Commission for UNESCO

The Programme Officer presented his reflections on the theme of the workshop. He defined "Popularization" as carrying one of two meanings namely spread of knowledge in science and technology to the masses or the acquisition of new science and technology for improving one's social and economic life. He stated that popularization is therefore important and it should lead to raising awareness, inculcating scientific spirit and eliciting vocations to scientific study and career. He pointed out that there is what is called the scientific temper (spirit) that reflects one's logical, rational and analytical thinking, systematic and orderly way of performance in all spheres of life, reasonable behaviour and conduct and a rational decision-making power. This temper and method of science he said portray one's overall personality, which must be clearly visible through actions. He said that the Scientific Method can be divided into five steps (according to one author *Manoj Patairiy*²) which would include: **curiosity or inquisitiveness** (basic element of scientific temper and method of science), **collecting information** or data by several means, **observation and analysis** to extract the correct information, **experimentation** (very important in science) and **results-** the final step in the methods of Science.

Various methods of Popularization that can be used in the schools include:

1. Science Clubs
2. Associations of Scientists or Science Teachers or Science Students
3. Prizes and Awards for Competitions in the various Science Subjects

Some Practical Popularization Activities to undertake at School level are many. The following are some of the examples:

- i. Annual Scientific Exhibitions or demonstration, workshops, lectures, conferences (interactive)
- ii. science quiz, science essay competition, Popular Public Talks on Science Topics
- iii. World Science Day Commemoration (Every 10th Nov.)
- iv. National Science Day (Previously every September UNCST.)
- v. Best Science Student/ Teacher Award (based on the results or writing evaluated by a committee)

² Manoj Patairiya: Science Communication: A Conceptual Approach, Dept of Science & Technology Communication, Gov't of India. www.hestories.info

- vi. Activities on local scientific issues (Essay/ Quiz Competition etc.)
- vii. Miscellaneous scientific activities especially during special open days
- viii. Mathematical Contests
- ix. “Edutainment” especially to build confidence in Mathematics which is the main constraint to Science studies

Important points about communication for successful popularization of the sciences and mathematics.

1. **Language:** Need to have good command of language and communicate in a manner easily understood. Always simplify concepts and terms.
2. **Topics:** Every topic should be dealt with in specific manner that is easily understood.
3. **Medium:** Use various media suitable to the target population or audience. These include Print, Audio/visual, Folk (Plays, stage performances, folk songs) and other forms of entertainment.

3.6. Performance challenges in Science and Mathematics Education

By Ssemuwemba Emmy, SESEMAT Program

In his report, Mr. Ssemuwemba Emmy of the Secondary Science and mathematics (SESEMAT) Program reported that the performance in science and mathematics has been poor for a long time (UNEB reports for last 8 years) even before Science became compulsory and this raises serious concerns about meeting the SDGs by 2030. He noted that this calls for all stakeholders to take action. Reporting the action by the Ministry of Education and Sports (MoES), he informed the participants that research by Kyambogo University (KYU, 2004) identified poor teaching methods as one of the factors responsible. It was on the basis of this that the MoES, started the SESEMAT initiative out of the need to address continued poor performance in Science and Mathematics at ordinary Level. He pointed out the Goal of SESEMAT as to “improve Secondary School Performance in Science and mathematics” and the Purpose of SESEMAT is to improve teaching ability of Science and Mathematics teachers at secondary level.” He said that the Goal and Purpose of SESEMAT are achieved by promoting three things: Good Lesson Preparation, Good Lesson Delivery and Active Learner Participation. This is expected to lead to Pedagogical paradigm shift. He informed the meeting that the MAJOR TASK is to organize, conduct and monitor in-service training. The tasks include: Carrying out needs assessment through supportive lesson observation, sensitization of stake holders and conducting and monitoring. He listed the strategies of SESEMAT one of which is by teachers attending in-service training (INSET) at national or regional levels in one of the following ways:

- i. Teachers are exposed to new ideas; revamp their knowledge of the subject matter, Educational Theory, curriculum development and any other aspect that would improve their professional competence.
- ii. Teachers exchange ideas on professional matters such as classroom practices and lesson delivery.
- iii. In-service Training of Teachers (INSET) during school holidays; INSET provides networking among teachers.

The second approach is through implementing outcomes of the INSETs by Planning and Implementing ALEI/PIEI (learner-centred) lessons and carrying out SARB to ensure CPD habitually.

The third approach is by creation of enabling environment.

The presenter informed the participants that various key stakeholders are needed for their roles in learner performance improvement. Based on roles, these stakeholders include: Teacher Training and Development (PRESET and INSET Institution), School environment and governance,

Policies (MoES), Social Factors (Learners' Family), Evaluation of Learning Outcomes (UNEB, DES) and Curriculum Content (NCDC).

The School administrators

The School administrators play a critical role in supporting and facilitating all their teachers to regional INSETs, ensuring and encouraging teachers to attend to their lessons, monitoring and evaluating teachers' lessons and giving technical support to the teachers whose lessons have been observed (especially by HODs).

On the quantitative Results of the SESEMAT Programme, he reported that there has been 364 Regional Trainers and 6500 teachers trained per year, the National Teachers Colleges have provided lecturers while the Primary Teachers Colleges provide tutors, sensitizations, and supportive lesson observations have been done, school-based CPD structures and Regional Based Initiatives for Science Mathematics established and teaching reference developed.

Among the challenges identified include: largely theoretical teaching (in case of unannounced visits), wrong attitude (Headteachers, Teachers, Learners and Society), inadequate Science and Mathematics teachers, reliance on untrained teachers, shoddy work by some teachers, inadequate teaching and learning resources, inadequate skills in resource mobilization, utilization, and improvisation, poor content mastery, large classes and in some schools, the administration discourages teachers to employ learner-centered methodology claiming that it delays syllabus coverage.

The presenter concluded by saying that there is a strong belief that improved lesson delivery is key to improvement in learners' performance and this requires coordinated joint effort of all the stakeholders as we work towards a shared vision of attaining the country's desired social economic status and achieving the SDGs by 2030.

3.7. Group Discussions

Five groups were formed and each group was given specific questions to discuss. These included the following:

- i. Discuss factors affecting the learning of sciences
- ii. Discuss the necessary elements that can ensure successful teaching and learning
- iii. Discuss the problems teachers face in preparing students/candidates for UNEB and propose appropriate intervention/solutions
- iv. Identify necessary things needed to be champions
- v. Discuss the issues in regard to curriculum interpretation and pedagogy

3.7.1. Presentation of the Results of the Group Discussions

3.7.1.1. Group 1: The Factors Affecting Learning of Sciences

- Attitude of the learners
- Nature of admission into classes for S.1 and S.5
- Poor reading culture of the learners
- The number of students per class or stream which affects assessment.
- Inadequate skilled Human Resources
- Advanced level subject combination performance
- Uncoordinated subject combination e.g. BAF, PAM
- Theoretical teaching minus practical

3.7.1.2 Group 2: The Necessary Elements to be provided for Success

i) General

- Review of the crowded curriculum
- Recruitment of more science teachers
- Construction of modern laboratories and supplying of quality chemicals and equipment
- UNEB questions must be restricted within the provided curriculum and syllabus
- The grading system must be based on the performance of the learners

ii) For Teachers

- Conducting practical lessons at all times
- The welfare and upkeep of the science teachers should be greatly improved

iii) For Students

- Career guidance and counselling must be intensified for positive attitude
- Administrative support
- Government support
- Guidance and counselling
- Adequate science tools for practical lessons
- Motivation of science teachers
- More incentives for science based courses
- Availability of skilled and well-trained science teachers
- Mentoring and skills for in-service

iv) Obstacles

- Inadequate funding/finances
- Negative attitude
- Lack of administrative support
- Lack of government support
- Lack of guidance and counselling
- Inadequate science tools and equipment
- Inadequate career guidance
- Low salaries for science teachers
- Inadequate number of science Teachers

3.7.1.3. Group 3: Problems Teachers Face in Preparing Students/Candidates for UNEB

- Inadequate coverage of syllabus
- Broad scope of teaching syllabus yet UNEB only sets a narrow section
- Large number of students in a class which become difficult for teachers to monitor
- Limited resources in terms of chemicals and apparatus
- Indiscipline acts like dodging class, late coming
- Absenteeism from school
- Poor funding for practical materials by administrators
- Inadequate workspace in the Laboratories during sessions.
- Late reporting by students to school especially boarding students
- Assessment language and interpretation by learners

Intervention/Solution:

- Team teaching
- Guidance and counselling
- Continuous Assessment of the learners
- Group work and collective responsibilities
- Improvisation

3.7.1.4. Group 4: Identify Necessary Things Needed to be Champions

- Positive attitude
- Administrative support
- Government support
- Guidance and counselling
- Adequate science tools for practical lessons
- Motivation of science teachers
- More incentives for science based courses
- Availability of skilled and well-trained science teachers
- Mentoring and skills for in-service

3.7.1.5. Group 5: Curriculum Interpretation and Pedagogy

- NCDC curriculum is absent in some schools
- Failure to interpret curriculum
- Inadequate facilities i.e. Laboratory technicians, text books
- Not enough time
- Inadequate teachers to implement the curriculum in some schools
- Some subjects have got bulky content such as biology and physics



Group representatives presenting feedback of discussions to the plenary.

4.0. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

Uganda Government's efforts for the last three decades in pursuing the United Nation's Agenda on promotion of the natural sciences still faces stiff challenges due to the low popularity of the natural sciences. According to the workshop, there are a number of factors that are teacher-related, funds and facility-related and student-related.

The teacher-related factors listed include theoretical teaching without practicals, inadequate number of science teachers, inadequate coverage of syllabus due to low teacher competence in the teaching subjects, poor teacher skills in educational theory, poor guidance to students, inadequate administrative support and low salaries for science teachers. The funds and facility-related factors include limited resources in terms of chemicals and apparatus and inadequate workspace in the laboratories during practical sessions and poor funding for practical materials by administrators. The student-related factors include negative attitude towards sciences, indiscipline acts like dodging class, late coming, absenteeism from school, late reporting by students to school especially boarding students, language barriers and poor interpretation by learners, nature of admission into classes for S.1 and S.5, poor reading culture of the learners, the number of students per class or stream which affects assessment and misguided subject combination e.g. BAF, PAM.

The workshop reaffirmed the call of the UN Secretary-General's Scientific Advisory Board (UNSG SAB) that all scientists and policy-makers alike should join hands to promote science for sustainable development in the Country, recognising it as a universal public good and the foundation for a sustainable world beyond being simply a tool for the achievement of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). On the emphasis that the basic sciences constitute a principal requirement for innovation, the need for a productive scientific environment, including long-term investments, special attention on gender equity including provisions for underrepresented groups and minorities in science would enhance diversity by building on the entire spectrum of society. The workshop concluded that to strengthen science education and increase science literacy and capacity-building in science at all levels, investments in science ought to be raised by establishing national minimum target investments for science, technology and innovation for both basic and applied science. It agreed that integrating scientific approaches would address the social, economic and environmental dimensions of sustainable development and respect for the diversity of knowledge systems.

4.2. Recommendations

The recommendations made were as follows:

1. The Ministry of Education should strengthen the implementation of the policy on the teaching and learning of natural sciences through appropriate interventions like adequate training of all teachers, recruitment of adequate teachers for Science and Mathematics, improvement of teachers' teaching skills and competences in basic scientific and mathematical knowledge including in curriculum interpretation, pedagogy and career guidance and counselling for students.
2. All Science and Mathematics teachers should teach and conduct practical lessons at all times. They should adopt appropriate teaching methodologies like team teaching, improvisation, sharing, continuous assessment of the learners, group work and collective responsibilities. Teachers should adopt the use of simpler languages and localize concepts in a manner that can easily be absorbed and understood by students and teachers alike so as to help in the long run in bridging the learning gap.
3. Teachers should also be the champions in popularizing the sciences and mathematics using schemes like Science Clubs, forming themselves into Associations of Science Teachers or teachers of particular science subject and instituting competitions in the subjects in various ways like science quiz, science essay competition and awarding prizes for the winners, or organising routine Public Talks on popular and topical science issues of the times.
4. The Government should revisit the White Paper on Education (The Kajubi Report) which had proposed that the Science teachers stay within their profession by benefitting from the various ladders of promotion. The recommended motivation packages for retention should also be implemented in various ways including providing various avenues and opportunities for them to go for further studies in the various Science disciplines.
5. The Government, UNESCO and other Stakeholders to support the institutionalisation of Some Practical Popularization Activities at School like Annual Scientific Exhibitions or demonstration, workshops, lectures and conferences (interactive). The United Nations Days like the World Science Day commemorated every 10th November need to be supported for better impact.
6. The Government, UNESCO and other Stakeholders should support the teaching and learning of sciences and mathematics by providing adequate science tools and equipment for practical lessons, motivation of science teachers with various incentives, mentoring and skills for in-service, provision of awards, prizes or scholarship schemes and motivational schemes like annual Best Science Student/ Teacher Award per School, District, Region and Country (based on the results or prescribed assessments done evaluated by specially appointed committee).

7. UNATCOM and SESEMAT should provide regular support and training to strengthen science teachers' capacities till all teachers are covered countrywide. This would help to regularly refresh teachers, expose them to new ideas and revamp their knowledge of the subject matter, educational theory, curriculum development and any other aspect that would improve their professional competence. Teachers will also have platform to exchange ideas on professional matters such as classroom practices and lesson delivery.

4.3. Closure and Way Forward

The Workshop was closed by the Programme Officer for Sciences, Dr. Dominic Mundrugo-Ogo Lali on behalf of the Secretary General. He thanked all the participants for attending the workshop and their active participation. He reiterated UNESCO's Natural Sciences sector strategy for strengthening science, technology and innovation as a basis of promoting the applied natural sciences. He urged all the participants to take up the recommendations of the workshop for implementation especially those that applied to them. He pledged to follow up those that were addressed to UNESCO and UNATCOM announcing that another round of training would be organised in the coming financial year. He also urged all the teachers to go back as champions to spearhead some of the principles taught during the workshop, share what they have learnt with their headteachers and all the other teachers so that when the monitoring and evaluation team visits, there would be progress to show for the training undertaken.

He announced that UNATCOM would organise a follow-up monitoring and evaluation exercise to assess the impact of the workshop and others in the various schools under the Natural Sciences.

He then declared the workshop closed.

5.0. ANNEXTURE

5.1. Annex I: Attendance List

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6.0 PRESENTATIONS

6.1 Annex II: Overview and Objectives of the Workshop



Presented at the Workshop of Science Teachers from Selected Secondary Schools

Dr. Dominic V. Lali Mundrugo-Ogo
Programme Officer, Sciences
Uganda National Commission for UNESCO
10th April 2017



Background and Overview

- The Uganda Government has for the last three decades advocated for prioritization of science, technology and innovation as the basis for development.



Overview Cont'd

- To actualize this plan, the government made the teaching and learning of science subjects compulsory in lower secondary schools in 2004 .
- Government also increased proportion of sponsorship to science-based courses at tertiary to 75%.



Overview

- Gov't also created 3 science-based universities to increase intake in science-based programs
- The gov't also developed the National Science Technology and Innovation (STI) policy in 2009 as a framework for promoting science and technology.



Overview

- According to the report released on 5 October 2016, the UN Secretary-General's Scientific Advisory Board (UNSG SAB) on 5th Oct. 2016 called upon scientists and policy-makers to recognize Science as crucial for achievement of the Sustainable Development Goals(2030 Agenda 2030) .



Problems

- Records show very limited basic Science research in Uganda.
- Most research is in applied sciences
- Most funds for applied research in agricultural sciences (NARO) and engineering and technology (UIRI);



Problems (cont'd)

- Additionally, there is slow technology adoption and diffusion in the country coupled with a weak legal framework to support innovation.



Problems

- UNEB reports show consistent annual decline (about 40% in performance in Secondary School Sciences and Mathematics over the recent past years since 2010 with failure rates in individual subjects like Chemistry being higher with only marginal passes of majority Monitor June 4th, 2015).



Problems

- That in 2014, only 20% of the total candidates who sat in 'O' level offered Mathematics, 14.4% offered Physics and 11.5% offered Biology at advanced level.
- That majority of these did not get principal level pass required for progression to further specialized studies in Universities and other higher institutions of learning



Problem

- That the situation was worse for girls.
- 75.6% of female candidates scored F9 in Chemistry compared to 66.7% boys who also scored F9 in 2011
 - 66.9% of girls failed Physics and 46.6% of girls failed Biology in 2012 up from 44.5% in 2011 (Daily Monitor June 25th, 2015).
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Overall Objective

To promote Science for Sustainable Development using teachers as Champions for Popularization of the Natural Sciences in Uganda.



Specific Objectives

- To document and share existing policy issues regarding the teaching and learning of sciences
- To document and debate the academic performance trends of the teachers in their teaching subjects
- To document and debate the performance of the students in the learning of science subjects



Objectives (cont'd)

- To evaluate the teaching methods used by the teachers in imparting knowledge in their subjects
- To share information on the performance of the students from PLE to the secondary classes and determine the impacts in later carrier choices.



Objectives cont'd

- To discuss the structures and policy mechanisms (governance) regarding the teaching and learning of natural sciences in the selected schools

6.2. Annex III: Causes of poor performance in Sciences and Mathematics at Secondary Level.

By Joyce.A. Ebal (Ag. PEO-UNEB)

UGANDA NATINOL COMMISON FOR UNESCO

Causes of poor performance in Sciences and Mathematics at Secondary Level.

Presented at a workshop for popularization of Science and mathematics using champion teachers

BY JOYCE A. EBAL
(Ag. PEO-UNEB)

10th APRIL 2017

1.0 INTRODUCTION.

1.1 OBJECTIVES OF THE PAPER

To highlight the causes of poor performance of students in science and mathematics as reflected in the candidates work at the national examinations

1.2 DEFINITIONS:

1.2.1 Science

- According to the Oxford dictionary of English, Science is a noun and is referred to as the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment.

- From Longman Dictionary of contemporary English, Science is knowledge about the world, especially based on examination and testing, and on facts that can be proved.

This implies that science is what is all around us and within us. Science, therefore, is closely associated with our lives. Scientific knowledge is acquired through the testing of facts and by making observations. It describes mechanisms of systems, natural phenomena, and presents explanations to their occurrences. It provides logical conclusions from experimental work and enables accurate predictions of events.

2.2 SITUATION ANALYSIS

The Government of Uganda, being aware of the ever growing importance of science in the socio-economic development of the country, in its attempt to create a society that is scientifically literate.

- In 2006 made the three core science subjects (Physics, Biology and Chemistry) compulsory at O level.T
- Government increased its sponsorship science students at the tertiary institutions to motivate students into science related fields.
- To improve on the teaching of sciences, Government has tried to put up laboratories, provide textbooks, chemicals and equipment, to Government schools and private schools that are in partnership with government.
- Government increased the salary of science teachers more than that of arts teachers
- Ministry of Education and Sports is providing in-service training for science and mathematics teachers through SESSEMAT.

All the above indicates the importance the Government attaches to science and mathematics, and its attempt to improve on the teaching and learning of science.

2.0 STATUS OF SCIENCE AND MATHEMATICS IN UGANDA

2.1 IMPORTANCE OF SCIENCE

- The importance of science in today's world cannot be under scored. The application of science in recent times has brought in rapid development in almost all fields including engineering, medicine, computer science, Business, management etc. that has greatly transformed the world. In fact, so great is its importance for man and society that the present day people live in the "age of science". Acquisition of appropriate scientific and technological skills is therefore necessary for a developing country like Uganda to cope with this growing challenge

**TABLE I:
PERFORMANCE IN
SCIENCES AT UCE
EXAMINATIONS**

YEAR	NO. SITTING	BIOLOGY			CHEMISTRY				PHYSICS.			
		% AT	2	6	8	% AT	2	6	8	% AT	2	6
2003	131,025	0.6	21.4	49.8	53925	2.5	27.9	57.8	52833	2.3	33.7	60.5
2004	143,204	1.1	24.5	54.8	60342	1.8	25.5	55.6	59559	5.1	46.0	74.4
2005	165,649	1.0	28.5	61.7	79083	2.0	22.0	49.7	80480	3.9	39.0	69.3
2006	165,277	0.2	19.8	52.2	164819	0.9	19.1	50.0	165012	2.5	31.8	62.7
2007	188,307	0.5	28.3	62.4	188163	0.7	19.3	33.1	188164	0.4	15.3	41.6
2008	195,741	0.8	24.7	59.4	195676	0.6	9.2	29.4	195682	0.5	16.5	41.1
2009	212,029	1.0	27.5	59.8	213882	0.7	9.7	39.9	211859	0.6	15.3	41.9
2010	257,195	0.6	18.9	49.9	257062	0.9	11.8	40.9	257146	1.0	18.2	44.9
2011	264,526	0.4	15.7	45.3	264418	0.6	7.7	26.6	264383	1.5	22.9	54.0
2012	261030	0.9	23.8	57.3	260867	0.9	11.3	35.3	260873	0.7	18.1	47.3
2013	285912	0.6	27.7	63.8	285786	0.5	8.1	30.6	285782	0.8	16.7	44.3
2014	303747	0.5	28.5	66.9	303757	1.4	11.7	34.0	303662	0.5	11.9	34.9
2015	303845	0.3	13.0	40.7	302792	1.3	13.9	42.8	303331	0.5	15.4	41.7
2016	314916	0.4	16.1	45.1	314110	1.3	11.4	40.1	314748	0.4	9.3	31.9

Source: (UNEB, 2005-16)

TABLE 2: PERFORMANCE IN MATHEMATICS AT UCE EXAMINATIONS

YEAR	NO. SITTING	Mathematics % AT		
		2	6	8
2007	189,081	1.9	27.2	76.9
2008	196,462	2.4	31.7	82.5
2009	212,679	3.1	26.9	73.5
2010	258,152	2.1	25.4	65.9
2011	261,258	2.5	23.7	64.0
2012	261,695	2.1	23.9	71.4
2013	286,610	4.2	27.2	66.3
2014	304,344	1.8	21.4	65.7
2015	304,333	3.0	32.2	79.2
2016	315,310	3.1	28.9	60.7

Source (UNEB,2007-2016)

3.0 CAUSES OF POOR PERFORMANCE OF STUDENTS IN UCE AND UACE SCIENCE AND MATHEMATICS EXAMINATIONS.

6.3. Annex IV: Curriculum Interpretation and Pedagogy in Science and Mathematics Education, Droti Asile James (MSc-Chem; BEd.; PGDCDD; Dip. Educ.) Curriculum Specialist-Chemistry

Workshop for Popularisation of Science and Mathematics Using Champion Teachers

CURRICULUM INTERPRETATION AND PEDAGOGY IN SCIENCE AND MATHEMATICS EDUCATION

Droti Asile James (MSc-Chem; BEd.; PGDCDD; Dip. Educ.)
Curriculum Specialist-Chemistry

Introduction

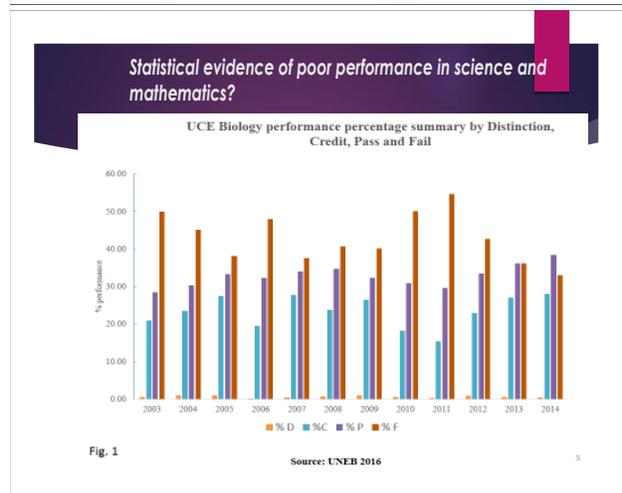
- ▶ What is curriculum?
- ▶ Statistical evidence of poor performance in science and mathematics
- ▶ Does curriculum interpretation affect student performance, learning outcomes and achievement?
- ▶ How does pedagogy in science and mathematics education affect performance in science and mathematics?
- ▶ Developing the Teaching of Science and mathematics
- ▶ What is the way forward to improving performance in science and mathematics?

What is curriculum?

- ▶ Curriculum refers to the knowledge and practices in subject matter areas that teachers teach and that students are supposed to learn.
- ▶ A curriculum generally consists of a scope, or breadth of content, in a given subject area and of a sequence of concepts and activities for learning.
- ▶ Standards typically outline the goals of learning.
- ▶ Curricula set forth the more specific means - materials, tasks, and discussions, representations - to be used to achieve those goals.
- ▶ Teachers are expected to implement the curriculum to achieve the intended goals set by **interpreting it correctly**.
- ▶ The question is "are the teachers doing it the right way?"

What is the trend in performance of science and mathematics over the years?

- ▶ there is a great public concern about performance of students in science and mathematics, particularly with the introduction of CSP in 2005.
- ▶ The performance has continued to drop over the years
- ▶ Gov't has put different interventions in place: science kits, new laboratories, CPD for science and Mathematics teachers (SESMAAT), etc.
- ▶ See Fig. 1, 2, 3 in the next three slides for the trends from 2003 - 2014
- ▶ Why has the performance continued to drop despite these interventions?



Does curriculum interpretation affect student performance, learning outcomes and achievement?

- ▶ **YES, to a greater extent.**
- ▶ **Curriculum interpretation** involves identifying the scope, or breadth of content, in a given subject area and the sequence of concepts and activities for learning to take place.
- ▶ It also involves identifying the appropriate strategies to be used to deliver the curriculum, the evidences of achievement of the learning outcomes and the resources to be used for effective learning.
- ▶ Again, it should involve how achievement of the learner can be measured and reported in terms of what the learner can do after learning.
- ▶ Good **Curriculum interpretation** results in a good lesson plan and hence enhancing learning of students

Template to “guide” in designing a good science and mathematics lesson

- ▶ **Content**—Identifying Important Content
- ▶ **Understanding**—Developing Student Understanding
- ▶ **Environment**—Creating a Positive Learning Environment
- ▶ **Assessment** – to improve student’s learning (FOR & OF)
- ▶ The Pedagogy for conceptual, procedural and NOS (Nature of Science) learning in science education could be more effective if the curriculum is restructured in the perspective of students’ learning and how their ideas might develop rather than being that of standard science.

How does pedagogy in science and mathematics education affect performance in science and mathematics?

- ▶ Pedagogy is the science and art of education, specifically instructional theory.
- ▶ Simply put, pedagogy is defined as many different types and variations of teaching.
- ▶ As such, there are many different ways in which students learn and teachers teach. Some of these ways are inclusive of **discovery learning, group learning, hands on learning, distance learning, and independent study.**
- ▶ The instructor (teacher) develops conceptual knowledge and manages the content of learning activities in pedagogical settings.
- ▶ *Becoming a good science and mathematics teacher doesn’t just happen; it develops as a result of a variety of experiences over time.*
- ▶ *It is a result of continuous reflection about our practice that incorporates lessons learned.*

What is the way forward to improving performance in science and mathematics?

1. The teacher should study the science of pedagogy and the practice of instructional design in order to be effective .
2. There is need to rethink how we structure the curriculum in science. Rather than being structured according to the ideas in scientists’ science, we need to think of the curriculum structure from the perspective of students’ learning and how their ideas might develop to those of standard science.
3. The curriculum should be so designed that the learners have the provision to learn things interconnecting the study topics to their real life experiences. One of the learning objectives must be the knowledge tackling real life situations in an effective way.

Way forward Cont...

4. SESMAT should revisit her strategies to improve teaching of Science and Mathematics to in CPD include curriculum interpretation.
5. Since pedagogy is defined as many different types and variations of teaching, the study of pedagogy should become part and partial of the pre-service teacher training programmes for all universities.
6. Since becoming a good science and mathematics teacher doesn’t just happen; and as it develops as a result of a variety of experiences over time, there is need to have **mentor science and mathematics teachers.** These will provide continuous reflection about good teaching practices that can be incorporated into lessons learned by the novice teachers.

6.4. Annex V: Performance challenges in S/M education

By Ssemuwemba Emmy

Performance challenges in S/M education

Ssemuwemba Emmy

1 SESEMAT Program

- Performance in science and mathematics has been poor for along time (UNEB reports for last 8 years) even before Science became compulsory.
- This rises serious concerns about meeting the SDGs by 2030
- Need for all stakeholders to take action

2 SESEMAT Program

Action by MoES

- Research by KYU (2004) identified poor teaching methods as one of the factors responsible
- MoES, started SESEMAT initiative out of the need to address continued poor performance in Science and Mathematics at ordinary Level.

3 SESEMAT Program

Purpose and Goal of SESEMAT

Goal of SESEMAT: “To improve Secondary school Performance in Science and mathematics”

Purpose of SESEMAT: “To improve teaching ability of Science and Mathematics teachers at secondary level.”

By promoting:

1. Good Lesson Preparation
2. Good Lesson delivery
3. Active Learner Participation

} Pedagogical paradigm shift

4 SESEMAT Program

Activities

MAJORTASK: To organize, conduct and monitor In-service training

Other tasks:

- Carry out needs assessment through supportive lesson observation
- Sensitization of stake holders
- Conduct and monitor SARB initiatives

5 SESEMAT Program

Strategies to achieve the above

Improving the teaching approaches by teachers. How?

By teachers:

1. Attending INSETs at national or regional levels, where: topical issues that address the challenges in the T/L of S/M

Strategies ...

- teachers can be exposed to new ideas, revamp their knowledge of the subject matter, Educational Theory, curriculum development and any other aspect that would improve their professional competence.
- teachers exchange ideas on professional matters such as classroom practices and lesson delivery.
- INSET provide networking among teachers

Strategies ...

2. Implementing outcomes of the INSETs eg by:
 - i. Planning and Implementing ALEI/PIEI (learner centered) lessons.
 - ii. Carrying out SARB to ensure CPD habitually.
3. Creation of enabling environment

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10/11/2017

Key players in the initiative

School administrators.

- Support and facilitate all their teachers to regional INSETs.
- Ensuring and encouraging teachers to attend to their lessons.
- Monitoring and evaluating teachers' lessons.
- Giving technical support to the teachers whose lessons have been observed (especially by HODs).

Quantitative results so far

- No 364 RTs and 6500 teachers trained per year
- NTC lectures
- PTC tutors
- Sensitizations , and supportive lesson observations
- Establishing school based on CPD structures through SESEMAT Activity Regional Based Initiatives for S/M trs
- Teaching Reference Development .

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SESEMAT Program

Challenges Identified from classroom observations

- Teaching is found to be largely theoretical (in case of unannounced visits)
- Wrong attitude (HTs, Trs, Learners and Society)
- Inadequate S/M teachers
 - HTs on mercy of the few available one
 - Hiring untrained teachers
 - Shoddy work by some teachers

Challenges Identified from classroom observations

- Inadequate t/l resources
- Inadequate skills in resource mobilization, utilization, and improvisation
- Some poor content mastery
- Large classes

In some schools, administration:

- Discourages teachers to employ learner centered methodology claiming that it will delay syllabus coverage.

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SESEMAT Program

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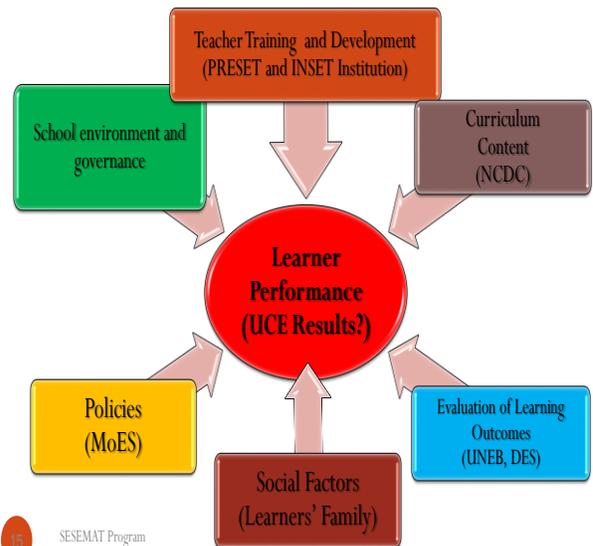
Conclusion

We strongly believe that improved lesson delivery is key to improvement in learners' performance

This requires coordinated joint effort of all the stakeholders as we work towards a shared vision of attaining the country's desired social economic status and achieving the SDGs by 2030.

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Various Stakeholders for Learner Performance improvement



6.5. Annex VI: Speech of the Secretary General, UNATCOM at the opening of workshop on Popularisation of Natural Sciences using Champion Teachers on 10th April 2017 At Arch Apartments, Ntinda.

- ✓ The Chairman, UNATCOM Board
- ✓ The Commissioner, Secondary Education
- ✓ The Officials from NCDC, UNEB and SESEMAT who are facilitators to the Workshop
- ✓ Participants, Teachers of Science from Selected Schools Country-wide
- ✓ The Representatives of the Media
- ✓ All invited Guests, Ladies and Gentlemen,

It gives me great honour and pleasure on behalf of the Uganda National Commission for UNESCO (UNATCOM) and on my own behalf to welcome all of you to this workshop. This workshop has been organised to share the ideas on the best ways possible in improving the performance in Sciences at the Secondary level and improvement of enrolment of our learners for careers in the Natural Sciences through popularization of the Natural Sciences using teachers as Champions. "Popularisation" here carries one of two meanings: the spread of knowledge in science and technology to the masses or the acquisition of new science and technology for improving one's social and economic life. For popularization of scientific knowledge to weave that knowledge into the existing culture, we must overstep the boundaries of receptive and instrumental understanding to relational and productive understanding. Popularisation is therefore important and it should lead to raising awareness, inculcating scientific spirit and eliciting vocations to scientific study and career.

This undertaking is in line with UNESCO's Natural Sciences sector whose current theme is 'Science for Peace and Sustainable Development' and Strategic Objective of: Strengthening science, technology and innovation systems and policies and promoting international scientific cooperation on critical challenges to sustainable development. The natural sciences is UNESCO's second major programme and UNESCO believes Science must respond to societal needs and global challenges through improved public understanding of, and citizen participation in science. UNESCO has been rewarding and giving recognition to outstanding research in areas such as environmental conservation, biosphere reserve management, freshwater, health and life sciences, prizes for young scientists, women in science and for the popularization of science, but sadly, there have either been no nominations or awardees from Uganda for these awards over the recent past decade. Moreover, there are currently increasing concerns about the continued low popularity of science and mathematics in the minds of students and hence students' continued poor performance in these subjects in the national examinations.

UNESCO as you may be aware is a specialized agency of the United Nations founded in 1945 to contribute to the construction of peace, human development and dialogue through education, the sciences, culture, communication and information. UNESCO's contribution to world peace and development is based on its five functions: Laboratory of ideas and foresight, Standard setter, Clearing house, Capacity-building and as Catalyst of International cooperation

As Laboratory of Ideas, UNESCO initiates planning and management through specialized institutes and provides state of art information, coaching and training to influence development agendas;

As Standard setter, UNESCO mobilizes universal agreements in the form of conventions, recommendations or declarations. Through its standard-setting action, UNESCO fosters multidisciplinary exchange towards universal agreements on key issues within its fields of competence;

As a clearing house, UNESCO works through enabling the gathering, transfer, dissemination and sharing of information and knowledge, supporting networks for research, exchange of research results and training, identifying innovative solutions and tests them through pilot projects;

UNESCO's capacity building role is through building human and institutional capacities and supporting training in all its fields of competence, including development of training programmes, materials and networks;

The catalytic action of UNESCO is in being at the forefront of promoting international cooperation;

UNESCO's Fields of competence are Four (4) namely Education, Science, Culture and Communication & Information. These fields of competence are programmed into **Five** (5) namely: Education, Natural Sciences, Social and Human Sciences, Culture and; Communication and Information.

In current theme in the Social Sciences Sector is "Learning to Live Together". UNESCO also works to ensure that education and health are not the privilege of those who are well-off. The three services are closely linked because a good quality education is the foundation of good health and well-being. For people to lead healthy and productive lives, they need knowledge to prevent sickness and disease. Similarly, for children and adolescents to learn, they need to be well nourished and healthy. Education is thus a catalyst for development and a health intervention in its own right.

You may also be aware, that the National Commissions for UNESCO (NATCOMs) are the interface of UNESCO with Member States at the national level and hence it is the NATCOMs that assist government Ministries, Departments, Agencies, Institutions, Individuals, Community Based Organizations, and NGOs in developing their plans and projects in line with the UNESCO's guidelines and programme framework. UNATCOM promotes the understanding of the objects and purposes of UNESCO among the people of Uganda, advises government on matters of UNESCO and plays all those roles that are necessary for implementation of the

programmes and activities in accordance with UNESCO standards and guidelines, recommendations and international conventions in all UNESCO's areas of competence. Today, having the representatives from 60 Schools from various Districts provides an excellent opportunity to establish partnership with the Schools and the Local Governments of origin.

Since its establishment 53 years ago in accordance with Article VII of the UNESCO Constitution, UNATCOM has been spearheading the promotion and implementation of UNESCO's mandate in Uganda, engaging partners at national, local, regional or international level and working with a worldwide network of National Commissions playing its core functions **of:** Consultation, Liaison, Information, Programme formulation, implementation, monitoring and evaluation. Our Vision of Uganda is *“A learning, cultured, informed and peaceful nation”* with the mandate of *contributing to the attainment of peace, justice, respect for human rights, freedom and security in Uganda through its programmes*

Our Mission is *to provide intellectual leadership, engage Ugandans to participate in and influence UNESCO programmes and activities and, to contribute to peace and sustainable development.*

Our Strategic Goals include raising UNESCO's profile in Uganda, increasing public awareness of UNESCO's goals and ideals, linking national priorities with these goals and ideals, engaging intellectual and cultural resources and capacities of Ugandans in UNESCO activities and providing support services in the fields of research and development in UNESCO fields of competence.

Strategically, under the Natural Sciences Programme, we strive to strengthen the national capacity to strengthen science, technology and innovation systems and policies and promoting international scientific cooperation on critical challenges to sustainable development.

I therefore thank all of you for turning up for this workshop.

Finally, I urge you all to pay very close attention and make the necessary contributions including recommendations for taking this subject forward. May I now with pleasure and honour invite the Chief Guest the Vice Chairman of the UNATCOM Board to make his remarks and officially open the workshop?

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