United Nations
Educational, Scientific and
Cultural Organization

The Republic of Uganda

Uganda National Commission for UNESCO

CAPACITY BUILDING
ON POPULARIZING NATURAL SCIENCES
IN UGANDA.

8th – 9th January, 2018

A report of training for Science Teachers from Poorly Performing Schools

United Nations
Educational, Scientific and
Cultural Organization

The Republic of Uganda

Uganda National Commission for UNESCO

Capacity Building on Popularizing Natural Sciences in Uganda.

A report of training for Science Teachers from Poorly Performing Schools

Published in July 2018

Capacity Building Workshop on Popularizing Natural Sciences in Uganda: A report of training for Teachers from Poorly Performing Schools

ISBN: 9789-970-400-37-9

Published in 2018

By Uganda National Commission for UNESCO
King George VI Way
P.O. Box 4962
www.unesco-uganda.ug
Fax +256-41-4259713

Cover Page
A group photo of the participants of the workshop taken on 9th January 2018

Printed and bound in Uganda.

Table of Contents

List of Acronyms v
Foreword vi
Acknowledgements vii
Executive Summary viii

1.0 Introduction 1
1.1 Objectives of the Intervention 1
1.1.1 Overall Objective 1
1.1.2 Specific Objectives 1
1.2 Targeted Participants 1
1.3 Expected Outputs 1
1.4 Methodology 1

2.0 Day One 2
2.1 Expectations 2
2.2 Introduction 3
2.3 Curriculum Interpretation 4
2.3.1 Presentation by Mr. Droti Asile James, Curriculum Specialist for Chemistry, NCDC 4
2.3.2 Discussion 6
2.4 Appropriate Techniques for improved teaching and learning in Science 7
2.4.1 Presentation by Dr. Kwetegyeka Justus Dean, Faculty of Science-Kyambogo University 7
2.5 Improved Strategies for Improved Teaching and Learning in Mathematics 8
2.5.1 Presentation by Dr. Fr. Henry Nsubuga Kiwanuka 8
2.5.2 Discussion 10
2.6 Methods of Simplification of Subjects for Learners; the Case of Chemistry Subject 10
2.6.1 Presentation by Mpamizo Gonzaga, Teacher and Education coordinator Uganda Royal Society of Chemistry 10
2.6.2 Discussion 11
2.7 Closing Day One 11

3.0 Day Two 12
3.1 Guidelines to conducting science practicals for effective learning in science and mathematics education 12
3.1.1 Discussion 13
3.2 Group Work 13
3.2.1 Recommendations 14
3.2.2 Evaluation 14
3.3 Closing Remarks 14
3.3.1 Representative of the teachers 14

3.3.2 Paul Musoke, SESEMAT 14
3.3.3 Rev. Fr. Dr. Henry Nsubuga Kiwanuka 15
3.3.4 Dr. Dominic Lali Mundrugo-Ogo – Programme Officer Sciences 15

5.0 Official Closing Remarks by Prof. Eriabu Lugujjo 16

4.0 Conclusion 17

6.0 Appendix 19
6.1 School action plans for teaching of sciences 19
6.2 Programme 23
6.3 Attendance List 25
6.4 Curriculum Interpretation 27
6.5 Appropriate Techniques for improved teaching and learning 29
6.6 Improved Strategies for Improved Teaching and Learning in Mathematics 32
6.7 Methods of Simplification of Subjects for Learners 39
6.8 Guidelines to conducting science practicals 43

List of Acronyms

IBSP	International Basic Science Programme
ICT	Information and Communication Technology
NCDC	National Curriculum Development Centre
SDGs	Sustainable Development Goals
SESEMAT	Secondary Science and Mathematics Programme
UNATCOM	Uganda National Commission for UNESCO
UNEB	Uganda National Examinations Board
UNESCO	United Nations Educational, Scientific and Cultural Organization
URSC	Uganda Royal Society of Chemistry

Foreword

According to the Medium Term Framework (2014-2022) of UNESCO, policy advice on science, technology and innovation (STI) will be provided as well as international scientific cooperation for advising inclusive 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.

Despite the decade long effort by the Uganda Government to enforce compulsory science education in the country, the sciences have not become popular and performance has instead remained dismal. Records from Uganda National Examinations Board (UNEB) indicates that between 2003 -2016, the percentage of students who attained distinction in the sciences ranged from only 0.1% - 1.1%, 0.5% - 2.5%, 0.4% - 5.1% and 1.8% - 4.2% in Biology, Chemistry, Physics and Mathematics (2007 – 2016) respectively. In terms of credit passes, more than 33.1% - 59.3%, 42.2% - 73.4%, 25.6% - 85.7% and 17.5% - 39.3% failed Biology, Chemistry, Physics and Mathematics (2007 – 2016) respectively from 2003 to 2016. Furthermore, the interests of students to pursue and specialize in science-based disciplines continue to be low.

In the midst of the increasing concerns in the country about this continued low popularity of science and mathematics in the minds of students, the Uganda National Commission organized a two-day workshop for 50 science teachers of the various disciplines from the worst performing secondary schools in all the four regions of the country.

It is hoped that this report will stimulate further interest in all stakeholders about the importance of promoting sciences in schools.

Rosie Agoi
Secretary General

Acknowledgements

This report is the result of the collaboration and support of many individuals and institutions. It would not have been possible without various stakeholders including representatives from the Secondary Science and Mathematics Programme (SESEMAT), the Ministry of Education and Sports (MoES), the Uganda Royal Society of Chemistry (URSC) and the National Curriculum Development Centre (NCDC).

In addition, we would like to acknowledge with profound thanks all the staff of UNATCOM and the interns for their invaluable contribution to this report.

We especially recognize Ms. Rosie Agoi, Secretary General of UNATCOM and Dr. Dominic Mundrugo-Ogo Lali, Programme Officer of Natural Sciences for the technical support extended to the planning, implementation and evaluation of the project.

All the presenters of the papers are gratefully acknowledged.

We further thank the Government of Uganda for funding this project.

Finally, special appreciation goes to all the participants for making the workshop a success.

Executive Summary

The report of the UN Secretary-General's Scientific Advisory Board (UNSG SAB) released on 5th October 2016 called upon scientists and policy-makers to promote a set of principles that underpin the crucial role of science for sustainable development. These principle include the recognition that sciences is a universal public good that helps lay the foundation for a sustainable world and is therefore a tool for the achievement of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs).

Records from Uganda National Examinations Board (UNEB) indicates that between 2003 -2016, the percentage of students who failed in Biology, Chemistry, Physics and Mathematics (2007 – 2016) was 33.1% - 59.3%, 42.2% - 73.4%, 25.6% - 85.7% and 17.5% - 39.3% respectively from 2003 to 2016. The records show that despite the decade long effort by the Uganda Government to enforce compulsory science education in the country, the sciences have not become popular and performance has instead remained dismal and the interest of students to pursue and specialize in science-based disciplines continued to be low.

In the midst of the increasing concerns in the country about this continued low popularity of science and mathematics in the minds of students, the Uganda National Commission organized a two-days' workshop with the theme "Innovative teaching awakens hidden talents in teachers and learners alike" for 50 science teachers of the various disciplines from the worst performing secondary schools in all the four regions of the country. The main objective of the workshop was to build the capacity of science teachers in popularizing the natural sciences in their schools as basis for sustainable development in Uganda.

The workshop involved speeches from leadership of UNATCOM and the Ministry of Education and Sports and presentation of papers from specialists in the fields of Curriculum, Examinations, Science Policy and Strategists along with discussions of the presentations, brainstorming, group work and plenary session discussions by the participants.

Among the issues raised, the teachers reported issues that relate to the staff including staffing shortage, limited knowledge and interest of teachers in their subjects and theoretical teaching and others that relate to teachers.

For solutions, the teachers proposed the adoption of team teaching, guidance and counselling, continuous assessment of the learners, use of group work for students to encourage their learning and improvisation, use of a cadre of teachers as champions with positive attitude, administrative support, guidance and counselling, more science tools for practicals and theory lessons, motivation of science teachers, mentoring and skills for in-service.

1.0 Introduction

1.1 Objectives of the Intervention

1.1.1 Overall Objective

To build the capacity of science teachers in popularizing the natural sciences in their schools to increase number of students taking up careers in science as basis for sustainable development in Uganda.

1.1.2 Specific Objectives

1. To disseminate and review the findings and recommendations of the last workshop.
2. To build teachers' capacity in curriculum interpretation and use of appropriate pedagogy and teaching approaches for effective learning of sciences and mathematics.
3. To create awareness on the various opportunities for natural science-based careers.
4. To provide knowledge and skills in improvisation of teaching and practical materials.
5. To discuss and recommend administrative and policy mechanisms for improved governance for facilitating the teaching and learning of natural sciences in the selected schools.

1.2 Targeted Participants

The teachers targeted were teachers of science from especially government-founded and government-aided schools that have been performing very poorly in the sciences and mathematics according to the records from UNEB. The selection took into consideration other factors like rural, urban, mixed and single sex, boarding and day schools. In total, 60 schools were sampled consisting of 13 schools from the four upcountry regions and 8 schools from central Uganda.

1.3 Expected Outputs

1) Results of past workshop adopted as basis for further intervention.
2) Capacity of teachers built in curriculum interpretation and use of appropriate pedagogy and teaching approaches for effective learning of sciences and mathematics.
3) Increased awareness among teachers on the various opportunities for natural science-based careers.
4) Increased Knowledge and skills of teachers in improvisation of teaching and practical materials.
5) A set of practical administrative and policy recommendations made for improved governance for the teaching and learning of natural sciences.

1.4 Methodology

The methodology involved speeches from leadership of UNATCOM and the Ministry of Education and Sports and presentation of papers from specialists in the fields of Curriculum, Examinations, Science Policy and Strategies along with discussions of the presentations, brainstorming, group work and plenary session discussions by the participants.

2.0. Day One

2.1 Expectations

The workshop was opened by Dr. Dominic Lali Mundrugo-Ogo, Programme Officer for Natural Sciences at Uganda National Commission for UNESCO (UNATCOM). He highlighted the theme of the workshop "Innovative teaching awakens hidden talents in teachers and learners alike".

The participants of the workshop then presented their expectations as follows;

Expectations by the teachers:

- To learn better methods of teaching
- To learn better ways of simplifying science
- To leave the workshop as changed people
- Get to know and discuss new ways and approaches of teaching
- Improve performance
- Share innovative ways of teaching sciences
- Learn Particular ways of teaching
- Learn methods of turning theory into praxis
- Improve how to work with the limited teaching time while using a practical approach
- Enhanced capacity of teaching natural sciences
- To get more specification from NCDC
- Policies of transfer of teaching revised
- Get skills how to teach theoretical and practical lessons
- Improving the interest of students
- See improvement after the workshop
- Change of attitude in teaching
- Close gap between NCDC and UNEB
- Get to know new principals of improvisation
- Go with knowledge to help learners

Expectations by the experts:

- Come up with way of improving teaching
- Discuss how to teach sciences for life, not just for examination
- Change of attitude
- Discuss on what can the people do, that are here? What can they change?

2.2 Introduction

Dr. Dominic Lali Mundrugo-Ogo explained the project concept in relation to the strategic plan, structure and mandate of UNESCO. He elaborated on the fact that UNESCO is the United Nations Organisation for Education, Science, Culture and communication whereby Education and Basic Sciences are the vital parts for the workshop.

Dr. Mundrugo-Ogo noted that the humanities often constitute the largest percentage of learners due to several factors. He cited societal conception of sciences being a 'no-go zone' for the girl child, that is, considered to be beyond their brain capacity, some science teachers having negative attitudes, hence discouraging learners, and extra effort required by science teachers which makes their number minimal as most people treasure their leisure time, a luxury science teachers cannot afford due to the nature of their work.

According to Dr. Mundrugo-Ogo, popularizing sciences is possible through creating awareness regarding its benefits. This, he says can be done through innovative approaches; career guidance, where people get to appreciate and understand sciences and giving individuals the right exposure, environment and opportunity to flourish, in his words "there are talented people who just need to be given the opportunity."

Dr. Lali making remarks during the workshop.

The programme officer who was also representing the Secretary General further noted that the Sustainable Development Goals (SDGs) cannot be achieved without science. In so doing therefore, science should not be used to destroy human life, but to promote it. He echoed UNESCO's preamble that since conflicts start in the mind, there is a great need to tame the mind so as to construct in it the defence for peace, and this can only be done through education.

He noted that science is recognised as a public good, and therefore a tool for attaining the SDGs, the reason why the government of Uganda has had a policy on compulsory science at ordinary level in secondary schools, though it is being revised. Nevertheless, he noted that there is still poor performance and declining interests, coupled with continuous low popularity of science. This therefore puts forward the need to strengthen science education to increase science literacy and capacity building in science at all levels.

He concluded his opening remarks by stating the objectives of the training workshop as follows:

- Capacity building, that is, to learn skills to make the sciences appealing.
- Share recommendations of the previous training for science teachers in April 2017
- Get exposed to opportunities for science practitioners
- Generate innovative ways/approaches of teaching the subjects.

2.3 Curriculum Interpretation

2.3.1 Presentation by Mr. Droti Asile James, Curriculum Specialist for Chemistry, NCDC

The Curriculum specialist noted that the interpretation done at training institutions is theoretical and as such, every teacher interprets the curriculum in his or her own way. According to him, good teachers are those in position to interpret the curriculum and choose appropriate methods of deliverance. Mr. Droti added that the main cause of failure of science subjects is that most teachers do not know how to interpret the curriculum. He noted that teachers should have content knowledge, technical knowledge and pedagogical knowledge, in his words 'have the content, but also mode of delivery'.

Mr. Droti further decried the fact that some teachers struggle to complete the syllabus at the expense of understanding by the students. He said, "if you cover the syllabus, then you are not exposing the curriculum".

Mr. Droti of NCDC making a presentation on Curriculum Interpretation.

In expounding on Pedagogical approaches, he indicated that there are various ways of enabling the learner to accomplish the purpose of learning. It includes strategies and methods of delivering knowledge to one's students. He also defined pedagogy as being able to convey knowledge and skills in a way that students can understand and apply. He noted that several pedagogical approaches exist, and that the selection depends on the teacher and the needs of the students.

There are two approaches of teaching, that is, teacher-centred and learner centred, which according to him depends on what is emphasized. He noted that unfortunately, teaching is being more emphasized than learning, yet there has to be more learning than teaching.

Most effective approaches for sciences and Mathematics Teaching and Learning

- An ethic of care, especially caring for classroom communities.
- Providing opportunities for individual and collaborative learning.
- Plan science and maths learning experiences to arouse interests, instead of just teaching to pass.
- Understand the tasks and examples to influence how students use and make sense of the subjects.
- Connect ways of solving problems to everyday life
- Carry out assessments for learning. Beginning of Term examples do not apply because there is no teaching that has been done, hence assessment cannot take place.
- Effective teachers model appropriate terms for their students. Some science terms are not easy to comprehend by the students.

- Carefully select tools and representations.
- Develop and use sound knowledge.

He cited that pedagogical knowledge and content are key in interpreting the curriculum, and that teachers should desist from teaching students to memorise, and rather aim at understanding.

2.3.2 Discussion

One of the participants argued that training for teachers should also be done in a practical manner. He regretted that Universities teach theories but send out students to do practicals.

Mr. Twebaze David, the Education Programme Officer at UNATCOM responded that there are lecturers who are not professional teachers and as such do not know pedagogy, though they have the content. He cited that UNESCO is coming up with a project on how to teach teachers. He urged the teachers to conduct themselves professionally in order to market their profession.

Some teachers cited that the chemistry syllabus is challenging, pointing to an example of Oxygen being a Senior one topic, with an equation, yet chemical equations are taught in Senior two. Mr. Droti responded that scope and sequence based on chronological and cognitive age is done when designing a curriculum. He however urged teachers to encourage the students by starting with simpler topics and giving them marks such that they sustain a positive attitude as intensive topics are introduced.

Other teachers, especially biology teachers complained about the time allotted to the syllabus. They blamed time factor to the usage of crude teaching methods by some of the teachers.

It was also proposed that UNEB should look at value addition to individual students, instead of regarding first grades as qualification for good performance.

The curriculum specialist also urged teachers to improvise, indicating that new content, especially for practicals is available. He also clarified that UNEB mandate is to make examination regulations, and it only takes directives from NCDC on matters to do with the syllabus.

Mr. Droti further revealed that the syllabus is in the process of being changed to accommodate new content, and he hopes that it will also address assessment issues given that there are few assessment experts. He finally put forward the need to alter mind-sets from being obsessed with marks, to intentional teaching that sprouts understanding and interest in subjects within both the teachers and learners based on pedagogy.

2.4 Appropriate Techniques for improved teaching and learning in Science

2.4.1 Presentation by Dr. Kwetegyeka Justus Dean, Faculty of Science-Kyambogo University

Dr. Kwetegyeka Justus, the Chairperson of the National Committee of the International Basic Science Programme, started his presentation by emphasizing the crucial role of sciences in the development of the country and the achievement of the Sustainable Development Goals. With almost 50% of Uganda's population being below the age of 15 years, science teachers are the ones who can arouse interest and provide the basic knowledge for future scientists, therefore the need for consistent support and access to the best teaching methods available.

Dr. Kwetegyeka provided some information about the state of Science Education in Uganda. Between 2003 (2007) - 2016, just about 53% passed the examinations in natural sciences and mathematics at all and only about 1.5% passed with distinction. He named several factors causing the bad results, among them staffing shortage, limited knowledge and limited interest of the teachers, limited time and laboratory equipment, inadequate syllabus coverage and teaching theoretical approaches of teaching.

PERFOMANCE

The average percentage of students who got a score of credit to pass 8 (2007 – 2016) OR 2003-2016 (Source: Concept paper-UNEB)

	BIOLOGY	CHEMISTRY	PHYSICS	MATHS
C3-P8	54.9	40.4	47.7	70.6
F9	45.1	59.6	52.8	29.4
Distinction	0.6	1.2	1.5	2.6

Capacity Building Workshop for Science Teachers 8-01-2018

4

He stated that those problems were not going to end anytime soon, but that all of us have to work with the given circumstances. He then mentioned solutions that were proposed by teachers in the last workshop in April 2017. For example, improvisation, mentoring, use of group works, administrative support and enhanced science tools for practical lessons.

On the attitude of current teachers, he said that emphasis is often on the teaching style, but in order to encourage students and get good results in the long term, teachers need to focus on the learning style.

Therefore, it is mandatory that teachers know their students, and most important are aware of what works, under which condition and for whom. They need to adapt their teaching methods according to the students.

To help teachers plan their lessons, Dr. Kwetegyeka mentioned the SESEMAT Teaching References, which not many teachers at the workshop seemed to know. They contain detailed knowledge on techniques of how to plan lectures effectively and how to monitor the results. For example, teachers should use different activities during one lesson in order to keep learners engaged and also work with activities of interest for the students, like the use of ICT, field trips and practical 'hands on' activities. The topics covered must also be relevant to real life issues of the learners. He emphasized that these measures don't have to be expensive. For example, school trips don't need to go far away, but instead there are plenty of interesting things that can be discovered close to the school. Regarding the use of ICT, he added that right now there is not a wide range of appropriate digital learning material available, but this would change in a few years.

He also advocated for a different approach by school authorities and leaders in dealing with the teachers. Teachers have to be made accountable for their teaching, but instead of controlling, administrators should offer active support and leaders should emphasize on compliance. Parents and community leaders should be engaged in the learning process, too, and collaborations at school level must be promoted.

Dr. Kwetegyeka also proposed a shift to a competencies-based curriculum that encourages interactive teaching and learning strategies. This will require a less content heavy curriculum that is not examination oriented. More emphasis has to be on locally available materials and long-term achievements. All of this aims at a more inclusive syllabus and prepares students with transferable knowledge for their working life.

See 6.5

2.5 Improved Strategies for Improved Teaching and Learning in Mathematics

2.5.1 Presentation by Rev. Fr. Dr. Henry Nsubuga Kiwanuka

Rev. Fr. Dr. Henry Nsubuga Kiwanuka noted that students perform very poorly in mathematics, despite its great importance as the foundation of all sciences and requirement for many studies, but also as the basis for everyday activities. Maths is furthermore very important for developing problem solving skills and learning abstract thinking.

He identified several factors that contribute to the poor performance in mathematics, which he divided into systematic factors on school level and on teacher/classroom level, societal factors, social economic

factors and pedagogical factors.
For the systematic factors he named poor leadership, lack of frequent inspection, lack of support and inadequate facilities at the school level and improper and ineffective teaching methods and shortage of materials at the classroom level. He also added the negative attitude of teachers, overcrowded classrooms, overload of the syllabus and the resulting heavy workload to the list.

As the societal factors, he mentioned a negative attitude of the students, mathematics anxiety, abstract/ logic thinking, and discouragement, perception of irrelevance towards mathematics and poor fluency of the English language. He also talked about gender related stereotypes against mathematics and science subjects, especially with the home duties of girls in mind.

Among the socio-economic factors he listed high illiteracy, the lack of academic role models, low parental socioeconomic status that results in inadequate learning resources and the education level of the parents and therefore little support from the family members.

He then listed the pedagogical factors, among them motivational skills of the teachers, teaching aid, improper teaching methods, lack of peer learning and the excessive use of the question-answer method. He also commented about the homework, which should be given regularly, but a short feedback to student is very important.

Rev. Fr. Dr. Henry Nsubuga Kiwanuka also stated that teachers should help students to develop mental capabilities, and not just rely on calculators.

He then talked about strategies for teaching and learning mathematics. First of all, he urged teachers to teach for conceptual understanding, which means to teach the knowledge of abstract ideas. This can be achieved by asking students to justify their processes, facilitate different solution methods and work on unfamiliar problems. The next method he proposed was to teach reasoning skills, what includes identifying similarities and differences, size or shape.

He also asked the teachers to promote problem solving and encourage creativity and collaboration in mathematics. He also proposed to provide an inquiry environment, so students take an active role in the learning and are more engaged.

For preparing lessons, he introduced the three-part mathematics lesson plan, which contains of first launching the task, secondly the task exploration and then summarizing the discussion in the third stage. The use of technology is another important factor to successfully teach mathematics. This includes interactive whiteboards, online assessments and calculators as well as computers.

Dr. Nsubuga Kiwanuka talked about the mental mathematical skills that need to be developed. Students should get the opportunity to discuss different ways to approach calculations, the focus should be on approaches and not on speed.

Further approaches on teaching mathematics included giving high expectations to the students, building

a positive attitude, and making mathematics fun by using apps, games, videos, stories and physical movement in the classroom. Teachers must also be aware of their impact on the students and their anxiety towards the subject. The anxiety can be reduced by incorporating students interest, encouraging students to ask for help and providing extra time for students with math anxiety.

Providing varied and ongoing assessments is important for improving students learning. Teachers can for example give assignments, day to day observations, conversations/conferences, demonstrations, projects, performances and tests. Providing feedback is the most important way to help students to learn. At last, he stated that teacher should give mathematics a meaning and context by including all STEM fields (Science, Technology, Engineering, and Mathematics) into the teaching.

2.5.2 Discussion

A teacher stated that most of the students do not have time for assignments because of the heavy workload. Dr. Nsubuga Kiwanuka proposed that teachers create time for assignments. He also urged the teachers to give feedback on assignments, because otherwise students do not learn from them.

Another participant reasoned that it takes every individual teacher's effort to improve both teaching and learning of sciences. According to him, every developing country goes through a phase of mindset change and systems development, and so Uganda is not the only country facing poor performance in Science subjects.

2.6 Methods of Simplification of Subjects for Learners; the Case of Chemistry Subject

2.6.1 Presentation by Mpamizo Gonzaga, Teacher and Education coordinator Uganda Royal Society of Chemistry

He started his presentation by citing the challenges faced by science learners and teachers such as inadequate facility, poor pay, limited number of laboratory teachers among others.

He urged the teachers to apply methods of teaching that lure learners to the subject, saying that practical teaching is fun, clever, simple and career giving. He encouraged the teachers to use of DVD demonstrations, industrial visits and field trips so as to connect the theory to practicals, revise promotions on averages, divide up the mole concept and invest in practicals.

He stated, for example, that the outer case of a dry cell is zinc, but also the black powder is Manganese IV oxide.

He noted that the workshop was intended to expose the teachers to better and simpler ways of teaching sciences, in his words, 'don't look at sciences as if they are very far, yet you live with them.'

Mr. Gonzaga demonstrates chemical bonding using atomic models.

He cited lack of sufficient resources by schools, which necessitates improvisation in order to change the attitude of learners through creating a situation that attracts learners to science and maths. He however urged that teachers should have the right and correct principles to base on during improvisation.

According to Mr. Gonzaga, improvisation can be in terms of either materials, or methods used hence the need to plan and be flexible.

He encouraged the teachers to undergo assessment by different individuals to evaluate and improve their methods. He noted that many teachers have a negative attitude towards improvisation, yet it is vital whether funds are available or not as it keeps cost of education expenditure low and encourages interactive learning.

He however indicated that factors such as culture, religion, ethics and misconceptions affect selection of materials for improvisation. He proposed that schools should establish rooms for improvisation to ensure easy understanding of content and participatory learning.

2.6.2 Discussion

The participants appreciated his demonstrations and noted that the training should have been more hands-on but were told it was limited to two days because of funding. They recommended that more practical approaches should be incorporated in the subsequent workshops.

2.7 Closing Day One

Mr. Paul Musoke from SESEMAT thanked all the participants and experts for coming to the workshop, which was then closed with a prayer led by Rev. Fr. Dr. Henry Nsubuga Kiwanuka.

3.0. Day Two

3.1 Guidelines to conducting science practicals for effective learning in science and mathematics education

Presentation by Mr. Ssemuwemba Emmy, SESEMAT

Mr. Ssemuwemba stated that practical lessons are important because they are motivational and improve ability, observational, recording and analytical skills. According to him, students have different learning styles, so teachers should react with different teaching styles. He said that teaching must cover the 3Hs: Head, Hand and Heart, because without incorporating all the three, the students will have a lot of knowledge, but fail to use it effectively.

He noted that practicals can be individual/ class practical work or study tours/ field trips. He advised that the study tours are started within and around the school environment, then extended to the outside environment. This saves money and would also prepare the students for bigger and more exciting expeditions.

Demonstrations are also vital for developing the visual and auditory aspects. These should however be properly planned to benefit all groups in case of large numbers.

Students should be encouraged to undertake projects since they are skills based, and cater for individual differences, capabilities and backgrounds. He also proposed to let students work together, so they can learn from each other.

Practicals must enable students to build new knowledge through critical thinking. The following are things to consider when planning an effective practical:

- Analysing/internalizing the concept
- Customizing/relating practicals to daily life
- Selecting simple appropriate apparatus
- Building on learner's knowledge
- Facilitating – allowing the students to construct their own knowledge.
- Guide, but let the students carry out the experiments so as to be more involved.

According to Mr. Ssemuwemba, a good practical lesson is one where the learners are active and in continuous dialogue with the teacher. He further said that questions set should stimulate reasoning among the learners. If students came to a conclusion by themselves instead of been told the answer, they are more likely to get interested in the topic and remember the topic.

3.1.1 Discussion

There were concerns about teachers who do not regard themselves as colleagues and thereby undo whatever their peers put in place. The facilitator advised that administrators should talk to the culprits privately to find a way forward.

A teacher asked where the SESEMAT teaching references mentioned in the presentation can be found. The facilitator said that they were distributed to regional committees and should be given to the schools by them. But because of funding issues, not enough copies have been done yet.

As regards UNESCO's role in popularizing sciences, Dr. Mundrugo-Ogo informed the participants that there are awards and prizes as well as scholarship schemes. He also said that UNESCO preaches good teaching methods. He however noted that there is reluctance among teachers to bring forward their researches.

He proposed that schools motivate teachers through annual scientific exhibitions, quizzes among others. He also urged teachers to improvise and design kits, as well as write project proposals, grants, and awards among others.

3.2 Group Work

The teachers were tasked to come up with action plans for their schools, that they would then implement, and UNATCOM together with SESEMAT would do an M&E to follow up. **See Annex 6.1**

Group discussions.

3.2.1 Recommendations

(i) The training should invite teachers for physics, chemistry, biology and mathematics from each school.
(ii) The trainnings should be decentralised to district level.
(iii) More such training workshops should be organised for the participants.
(iv) There should be more hands on in the presentations to excite more of the improvised methods.
(v) The workshop should be organised annually.
(vi) Practical lessons eg Polymerisation of Ethane should be demonstrated during subsequent trainings.
(vii) Handouts should be given out after presentations.
Time management should be put into consideration.
(viii) Certificates should be given to the participants to build their CVs.
(ix) Government policies should address workload of science teachers on ground by enrolling more teachers.
(x) Teachers need to adhere to internal locus of control for improved performance and build interest in learners.
(xi) Encourage more teachers who make innovations and help them where necessary.
(xii) Private schools should also be included during trainings.

3.2.2 Evaluation

The entire workshop was evaluated by participants, 95% said that their expectations had been fully met, 75% said the invitation was good 97% rated the venue as good, 82% rated the meals as good and the entire 100% rated the training content as good.

However, the following recommendations were made for future workshops.

(a) In the subsequent workshops, there should be a reporting day in the invitations to give people ample time to prepare and travel.
(b) Invitations should be sent in time, and venue clearly stated. The terms and conditions of attendance be specified.
(c) Proper allocation of time should be done for better enhancement of knowledge.

3.3 Closing Remarks

3.3.1 Representative of the teachers

The representative of the teachers said that although he was selected for the training as one whose subject was worst performed; he would improve after the training. He however wondered whether he would be in position to complete the syllabus if he taught the SESEMAT way. He said that he would also reduce on the number of schools where he was a part timer to focus on delivery rather than financial exploits. He further noted that SESEMAT tells you to teach in a certain way, but examinations come in a different way. He was however encouraged to use improvised materials but harmonise with the actual equipment.

3.3.2 Mr. Paul Musoke, Head of SESEMAT

Mr. Musoke thanked UNATCOM for organising the workshop and indicated that such initiatives are important since science and mathematics are key to development. He also urged the teachers to take the training seriously for self-improvement. He encouraged them to form a consortia so as to better

understand how and what to do. He indicated that there is no value in finishing the syllabus when students have not understood, hence the need to devise means of how to make them understand. He cited that there is a lot of content that is obsolete and that the volume of the curriculum is being addressed through the on-going curriculum review. He called upon the teachers to do their best to complete the syllabus, but above all ensure that the learners understand.

He encouraged the teachers to improvise, such that students get a feel of the practical approach and urged them to improve the teaching and learning of science and mathematics. He thanked UNATCOM and other organisers of the workshop.

3.3.3 Rev. Fr. Dr. Henry Nsubuga Kiwanuka

Rev. Fr. Kiwanuka noted that strategies have been given on how to popularise science and mathematics, but the teachers ought to emphasise life learning of the subjects (applicability). He hoped that the teachers get to help their learners to love and appreciate the value of sciences in their lives.

3.3.4 Dr. Dominic Lali Mundrugo-Ogo – Programme Officer Sciences

Dr. Dominic Lali Mundrugo-Ogo thanked everyone for attending the workshop. He stated that this topic has something close to the heart of everyone organising the workshop, because not a lot of progress has been made in the last ten years. The topic is very important for UNATCOM and UNESCO, being the United Nations Organisation dealing with the sciences.

He expressed concern that science might not be mandatory in the future, because a lot of people are complaining about the bad results in that field. But that is not the way to go. Instead, we must tackle the problems and find solutions for all difficulties. The current performance should not be used as a reason to abandon increased support for sciences but instead attract more support.

He reported that alot of studies have been done in this field, but UNATCOM wanted to bring the teachers together and discuss the problems with them. In the last workshop held at the beginning of the year, the teachers were complaining about the low interest of the students in scientific topics. So, this workshop was all about making the learners interested in science and making them scientists themselves.

4.0. Official Closing Remarks by Prof. Eriabu Lugujjo

Prof. Lugujjo urged the teachers to continue learning, saying that physical sciences are the stem to professional science, and so they should use what they have to simplify their illustrations. According to him, teachers focus on giving notes, rather than striving to help learners understand. He cited that Senior One is a foundation and an entry point to career and should therefore be given due diligence. He noted that the role of the teacher is to harness the endowment that exists within every learner, emphasizing the need for teachers to have objectives for their learners at the start of every lesson.

"The number of physical scientists is declining, yet the population is growing at the fastest and people are unemployed," he said. The professor continued to say that a high population that shies away from sciences is dangerous. He therefore proposed that a strategy of using the high population to promote sciences is employed, through capturing the learners from as low as Senior One. He further agitated for increased pay for science teachers, in his words "think afresh and let us situate ourselves to increase the number of science practitioners."

Prof. Lugujjo also called upon the teachers to take off time for self-reflection, saying that mobile phones have become a problem as too much time is spent on the digital platform thereby leaving no room for practice.

The teaching of sciences should also be localised. It is possible that the learners do not understand because they are taught in a foreign language, English. He says that the renowned scientists went through systems of education where they were taught in their native languages.

He also said that women should be encouraged to do sciences as they influence the children, unlike in the past where it was culturally assumed that women could not do Maths.

The professor declared that salary enhancement is being done to retain the teachers. However, he urged them to upgrade in education levels such that in case of opportunities, they can favourably compete. He further called upon the science teachers to be committed, saying the profession has its rewards, though some may not be physical.

5.0. Conclusion

The participants developed science teaching Action Plans for implementation upon return to their schools. The action plans are attached to the report. **See Annex 6.1**

In a nutshell, the training workshop that brought together science teachers from worst performing schools in the science subjects, mostly rural schools was successful. The teachers were able to share ideas of how best to improve on the teaching and learning of sciences in their respective schools. Emphasis was made on the issue of improvisation to enhance the teaching of practical lessons. Most of them hoped to become better through improving their methods of delivery, hence recommended for more such trainings in the year and other years to come.

The professor then posed for a while and asked for a feedback. One of the participants, Mark Richard Nsamba, cited that teachers are not motivated and are underpaid. It is also the reason as to why they cannot further their studies.

The deputy head teacher of Warr Girls, Ms. Jacinta Lekea wished there was a bigger forum for the kind of teacher training that took place in the workshop, she said that teachers always ask for monetary allowances and are not aware of the other benefits that accrue from teaching sciences. She urged that teachers should do their work for the purpose of the child, entrusted to them for learning.

In response, the professor thanked the teachers for the feedback and noted that the world is philosophical in nature, where government promises but cannot sustain. He noted that there is need for a new culture, a human being has both primary and derived duties.

He finally thanked all the teachers in the workshop for responding to the call by UNATCOM for the training. He noted that UNESCO is an International Organisation with no money but has knowledge and sets standards. He also emphasized that every individual is endowed, and only needs a conducive environment to exploit the endowment. He concluded by also thanking SESEMAT, Kyambogo University and Uganda Martyrs University for having been part of the training workshop. He then declared the training workshop closed.

The Guest of honor Prof. Lugujjo (centre) and facilitators in a group photo with the participants at the closure of the workshop.

6.0. Appendix

6.1 School action plans for teaching of sciences

PHYSICS GROUP

topic	Curriculum interpretation and pedagogy	Key terms for definition	Theoretical approaches to use	Practical improvisation	Teaching and learning methods	Justification for the method selected	Expected results	Time frame (Hours)	Period
Measurements	quantities and units	• mass • length • time	definition of units • instruments used	• use of a watch/clock • using a meter ruler, knife edge and mass	• demonstration • experimental	• appropriate for large numbers. • arouses curiosity	• ability of learners to measure mass, time and length.	4	6
Heat	Temperature and heat transmission	• temperature • heat • Kelvin scale	• Thermometer to measure body temperature	• boiling water using a stove	• improvising a thermometer by a plastic pen	• cheap and easy to apply	• ability to temperature from scale.	4	6
Light	Reflection at plane surfaces	• regular reflection • a beam • a ray	• same size of object and image in a mirror	• hair combs used by students with mirrors	• -brainstorming	• appropriate for discovery and level	• ability to appreciate properties	2	3
Electricity	Symbol circuits	• current • cell • electric ircuit	• lighting e.g torch	• Acid as a source of power.	• Demonstration	Easy to get material to use.	• ability to connect to produce light.	2	3
Magnetism	• Types of magnets • Properties of magnets	• poles of a magnetic field	• use of magnetic objects like Iron, Tin, Steel.	• Magnetized object by induction	• -demonstration	• suitable for the topic	• ability to identify magnetic objects using their properties	2	3

BIOLOGY GROUP (WARR GIRLS S.S)

Topics	Curriculum interpretation and pedagogy	Key terms for definition	Theoretical approaches to use	Practical improvisation	Teaching and learning methods to use	Justification for the method selected	Expected result	Time frame (weeks)	Period
Classification	• Relate organisms A sense of diversity of living organisms in the world.	• Taxonomy • Nomenclature • Taxonomic categories • Classification	• Use flow chart to categorize organisms	• Field/trip work on the compound	• Guided discovery • Discussion • Chalk of talk	• Participatory • Interesting	• Maximum participation	12	48
Flowering plants	Benefits of plants to man	• Roots • Stem • Flowers • Leaves • Fruits	• Charts (structures)	• Fieldwork	• Observation • Recording • Discovery	• Participatory • Hands-on	• Recording skills • Observation skills	24	96
Soil	Recognize soil as a resource for conservation	• Weathering • Profile • Texture • Erosion/control	• Charts • Explanation	• Fieldwork	• Discovery • Experimentation	• Readily available soils • Prior knowledge of learners	• Observation skills • Recording skills • Manipulation	12	48
Nutrition	Benefit of nutrients in living organisms	• Autotrophic • Heterotrophic • Nutrients	• Charts • Explanation	• Experimentation • Field work • Project work	• Guided discovery	• Interesting • Participatory • Hands-on	• Observation skills • Recording skills • Manipulation	24	48
Ecology	Appreciate interrelationships between organisms and environmental conservation	• Ecosystem • Habitat • Community • Population • Niche	• Explanation • Charts	• Project • Field excursion	• Guided discovery • Group discussion	• Participatory • Interesting • Uses previous experience of learners	• Appreciation of natural environment	6	12

MATHEMATICS GROUP

Topic	Curriculum interpretation and pedagogy	Key terms for definition	Theoretical approaches to use	Practical improvisation	Teaching and learning methods to use	Justification for the method selected	Expected result	Time frame (weeks)	Period
Vectors	Movement in specific and alternative directions	Positions, directions and size	use of drawn diagrams	starting from some point to arrive at the same destination through different routes	Demonstration and discussion	Active participation of learners	Lifetime appreciation	2	12
Simultaneous equations	Two equations with two variables unknown	• Simultaneous • Elimination • Substitution • Graphs	Elimination and substitution	Graph papers improvised.	Demonstration and discussion	Active participation to cater for the 3 domains	Better way of solving related problems	1	6
Matrices	positions, representation and storage	• Rows • Columns • Diagonal	Addition, subtraction and multiplication	Grouping and manipulation	Demonstration and discussion	Learner centered approach	solving long life problems	2	12
Statistics	Data collection, display, presentation and interpretation	• data • mode • mean • median	• Calculation of mean, mode and median	Group students according to their ages	• Demonstration • Guided discovery	Building on prior knowledge	Be able to interpret data	2	12

CHEMISTRY GROUP

Topic	Curriculum interpretation and pedagogy	Key terms for definition	Theoretical approaches to use	Practical improvisation	Teaching and learning methods to use	Justification for the method selected	Expected result	Time frame (weeks)	Period (lessons)
Electrolysis	movement of ions/ electrons	• Electrolysis • Electrolytes • Ions • Electrodes • Electrons	Show that electrolytes are collection of ions	• lemon fruit • plastic water bottle • Carbon rod from dry cells	• Brainstorm • work stations	• learner centered • large class	Deflection of the volt meter	4	16
Mixture	Types of mixture, composition, separation	• mixture • solution • homogeneous • heterogeneous	Explanation with examples	sorting rice, cooking oil and water mixture	Problem based method	More information comes from learners	Physical separation of components.	2	8
Matter	• Composition of matter • States	• Matter • Particles • Atoms • Molecules	Movement of particles within the states	• Bee wax • Candle wax • Water • Heat source	Work stations	Involve the learners	Changes of state	1	4
Acids and Bases	• Properties • Nature	Acids, Bases, Indicators and Alkalis	Explain that many substance occur in nature	• Flowers • Lemons • Oranges • Banana peelings	• Brain storm • Constructs	Available items that can be picked by learners	Distinction between Acids and Bases	2	8

6.2 Programme

Uganda National Commission for UNESCO
2nd Floor, Embassy House, King George VI Way

PROGRAMME FOR TEACHERS' CAPACITY BUILDING FOR POPULARISATION OF SCIENCE IN SCHOOLS WITH POOR PERFORMANCE IN SCIENCE HELD ON 8TH TO 9TH JANUARY 2018 IN SESEMAT FACILITIES, KOLOLO, KAMPALA.

Date/Time	Activity	Responsible/Remark
	8TH January 2018:	
08.00-08.20 am	Registration of Participants.	All/SESEMAT/UNATCOM Secretariat
08.20-08.35am	Introduction of Participants and their Expectations	All
08.35- 08.50	Workshop Objectives	Programme Officer
08.50-09.10am	Welcome Remarks	SG/UNATCOM
09.10-09.30am	Opening Remarks	Chairman Board, UNATCOM
09.30 -10.00am	The Policy of Science & Mathematics Education: Current Status and Way Forward.	Commissioner Secondary Education/MoES
10.00-10.20am	Feedback on the Findings of the April 2017 Workshop	Programme Officer/UNATCOM
10.20-10.30am	Question and Answer Session	All
10.30-11.00am	TEA/COFEE BREAK	
11.00-11.30am	Curriculum Interpretation and Pedagogical Approaches for effective Science and Mathematics Education	NCDC (Mr. Droti J.),
11.30-12.00pm	Methods of Simplification of subjects for Learners: the Case of Chemistry Subject.	Gonzaga Gonza, Uganda Royal Society of Chemistry, Bukindaa
12.00-12.20pm	Question and Answer Session	All
12.20-12.50 pm	Principles of Improvisation in the face of scarcity of materials for effective teaching and learning in Schools.	SESEMAT-Geoffrey/NCDC-Droti
12.50-1.00pm	Question and Answer	All
1.00-2.00pm	LUNCH BREAK	
2.00-2.30pm	Improvement of Performance in Sciences	UNEB –Joyce Ebal

P.O.BOX 4962 Kampala- Uganda. Tel: 256- 41-4259713, 0312 111571 Fax: 256-41-4258405
Email: admin@unesco-uganda.ug Website: www.unesco-uganda.ug

Uganda National Commission for UNESCO

2nd Floor, Embassy House, King George VI Way

	and Mathematics at Secondary Level	
2.30- 3.00pm	Guidelines on Conducting Science Practicals for effective learning in Science and Mathematics Education	SESEMAT-Geoffrey/Paul.
3.00- 3.30pm	Appropriate Administrative mechanisms for improved teaching and learning in Science and Mathematics.	Chairman, National IBSP Committee
3.30-3.40pm	Question and Answer Session	All
4.40-4.55pm	Group Formation	
4.55-5.00pm	EVENING TEA BREAK	
5.00pm	Group Work	
	9th January 2018	
08.00-08.20 am	Registration	
08.20-08.35am	Recap of Day One	Participants' Representative
08.35- 09.20am	Group Work	All
09.20-10.20am	Group Presentations/Plenary	All
10.20-11.00am	TEA/COFFEE BREAK	
11.00-11.30am	The UNESCO Natural Sciences Strategy 2014-2021 and Opportunities for Science-based Careers	Programme Officer/NS
11.30-11.40am	Question and Answer Session	All
11.40-12.00Noon	Wrap Up and Recommendations	Rapporteur
12.00-1.00pm	**CLOSURE**	
	Participants' Representative	
	Programme Officer	
	Secretary General	
	Minister of State for Higher Education	
1.00pm-2.00pm	LUNCH AND DEPARTURE	All

6.3 Attendance List

SN	Name	Institution
1	Okello Alex	Agwata S.S.
2	Ezaku Richard	Anyavu S.S.
3	Alanyu Max	Apac S.S.
4	Jadribo Luwayi	Aringa S.S.
5	Amagu Paulino	Arua S.S.
6	Tukwatsibwe John	Biguli S.S.
7	Magoola Patrick	Bishop S.S.
8	Sanyu Paul	Buginyanya Comprehensive S.S.S.
9	Tiberindwa Vincent	Buhimba S.S.
10	Kayabya Fred	Bukanga Seed School
11	Masereka Isaac	Bumadu Seed S.S.
12	Warere Tom	Butiru Model Comp S.S.
13	Kamanyire Sam	Buyanga S.S.
14	Kapere Philip	Chesower S.S.S.
15	Andema Lucius	Itula S.S.
16	Okomo Francis	Kabermaido S.S.
17	Anziku Levi	Kabong S.S.
18	Hamga Medard	Kabwangasi S.S.
19	Maaka Richard Nsamba	Kaliro High School
20	Twinomuhangi Joseph	Karungu S.S.
21	Tumusime Johnstone	Kihanda S.S.
22	Nuwagaba Tom	Kisinga Vocational S.S.
23	Akankwasa Felix	Kisoro H.S.
24	Baguma Robert	Kuruhe H.S.
25	Muhumuza Rabbon	Kyamate S.S.
26	Tumusime Judith	Kyenjojo S.S.
27	Idrifua Dominic	Laropi S.S.
28	Manga Godfrey	Mungula S.S.
29	Ochola Paul Kenneth	Nadunget S.S.S.
30	Serunkuma Jimmy	Nakapiripit S.S.S.
31	Nabukwasi Betty	Nambulu S.S.S
32	Abwot George Michael	Ngora Girls S.S.
33	Opio Walter	Nkoma S.S.
34	Asemo Teddy	Nyai S.S.S.
35	Buga Biajo	Nyarilo S.S.
36	Anguyo Sam	Obongi S.S.
37	Kibbaalya Yoweri	Okapel H.S.
38	Okello Benjamin	Opit S.S.S.

SN	Name	Institution
39	Odeku Charles	Otumbari S.S.
40	Opwomya Omony Robert	Pabbo S.S.
41	Olanya Joel	Padibe S.S.
42	Oriba Darious	Pakwach S.S.
43	Onoria Peter	Pallisa S.S.
44	Ochieng Benard	Rubongi S.S.
45	Mugerwa S. Addsan	St. Charles Lwanga Lwangiri
46	Auma Pamela O.	St. John Bosco
47	Lutaaya Dickson	St. Augustine S.S.
48	Lekea Jacinta	Warr Girls S.S.S.
	Facilitators / Organisers	
01	Namisi Geofrey	MOES/SESEMAT
02	Noah Agaroy	UNATCOM
03	Angella Namukwaya	UNATCOM
04	Ssemuwemba Emmy	MoES-SESEMAT
05	Hannes Hieronimi	UNATCOM
06	Dr. Dominic Lali Mundrugo-Ogo	UNATCOM
07	Nancy Okwong	UNATCOM
08	Prof. Eriabu Lugujjo	Chair, UNATCOM
09	Musoke Paul	MoES-SESEMAT
10	Ogal Vincent	UNATCOM
11	Irene Mutumba	UNATCOM
12	Ruthi Kalema	UNATCOM
13	Mpamizo Gonzaga	URSC Centre Bukinda
14	Fr. Henry Kiwanuka	Ug. Martyrs University
15	Dr. Kwetegyeka Justus	Kyambogo University
16	Droti Asile James	NCDC
17	Twebaze David	UNATCOM

6.4 Curriculum Interpretation

Capacity Building Workshop for Science Teachers from Poorly Performing Schools in Uganda

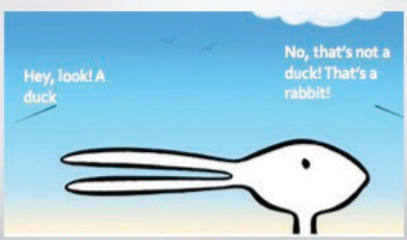
CURRICULUM INTERPRETATION AND PEDAGOGICAL APPROACHES FOR EFFECTIVE SCIENCE AND MATHEMATICS EDUCATION

Droti Asile James
(MSc, MEDCDD, BEd., PGDCDD, Dip. Educ.)

Presentation Outline

1) Curriculum Interpretation
2) Pedagogical approaches
3) Effective pedagogical approaches for Science and mathematics Education
4) Conclusion

1. What is Curriculum Interpretation?



Similarly, **Prepared curriculum materials**, the product of an external curriculum development process, can be interpreted in many ways (Ben-Peretz, 1975)

Curriculum Interpretation Cont…

- **Curriculum interpretation** is a strategy for engaging teachers and student/teachers reflectively in making educational sense of **curriculum** materials.
- Educational approaches or teaching models may provide criteria for interpreting curriculum materials.
- Teachers need a rich range of criteria for interpreting curriculum materials and revealing the possible educational opportunities embodied in them.
- Teachers who are able to differentiate between various aspects of curriculum materials, who are well practiced in thinking about curriculum potential, may be better equipped to make professional decisions about the way materials could be used in diverse educational situations. MONITOR - Teachers donot know curriculum Intepretation.docx

2. What are Pedagogical approaches?

- ***Pedagogy*** is an encompassing term concerned with what a ***teacher*** does to influence learning in others.
- **Pedagogy** refers to the "interactions between teachers, students, and the learning environment and the learning tasks."
- This broad term includes how teachers and students relate together as well as the instructional **approaches** implemented in the classroom.
- Thus, **Pedagogy** can be defined as the art of teaching. **Pedagogy** involves being able to convey knowledge and **skills** in ways that students can understand, remember and apply.

Pedagogical approaches Cont…

- The Methods, strategies, and/or styles of instruction that the teachers use to teach students are called pedagogical approaches.
- **Pedagogical skills** can generally be divided into classroom management **skills** and content-related **skills**.
- Several pedagogical approaches exist, and the selection of the strategies are according to the beliefs of the teacher, the needs of the learner and the demands of the task. Pedagogical approaches - LINK.docx

Teaching and Learning approaches

- Approaches – Teacher – centred, Learner-centred
- Methods – Problem based (Inquiry-based), Working Stations, Project based and Contracts
- Techniques – lecture, brainstorming, discussions,, talk and chalk, etc
- Tools – charts, maps, apparatus, computers, etc

3. What are the Most Effective pedagogical approaches for Science and mathematics Education?

Figure 1: Professional competence of teachers
Adapted from Blomeke and Delaney (2012)

Effective pedagogical approaches for Science and mathematics Education Cont…

1) Caring classroom communities that are focused on mathematical goals help develop students' mathematical identities and proficiencies. (**An ethic of care**)
2) Effective teachers provide students with opportunities to work both independently and collaboratively to make sense of ideas.
3) Effective teachers plan Science/mathematics learning experiences that enable students to build on their existing proficiencies, interests, and experiences.
4) Effective teachers understand that the tasks and examples they select influence how students come to view, develop, use, and make sense of mathematics. (**Worthwhile mathematical/science tasks**)

Effective pedagogical approaches for Science and mathematics Education Cont…

5) Effective teachers support students in creating connections between different ways of solving problems, between scientific/mathematical representations and topics, and between mathematics and everyday experiences. (**Making connections**)
6) Effective teachers use a range of assessment practices to make students' thinking visible and to support students' learning. (**Assessment for learning**)
7) Effective teachers are able to facilitate classroom dialogue that is focused on mathematical argumentation. (**Mathematical/Science communication**)

Effective pedagogical approaches for Science and mathematics Education Cont…

8) Effective teachers shape scientific/mathematical language by modelling appropriate terms and communicating their meaning in ways that students understand. (**Mathematical/Scientific language**)
9) Effective teachers carefully select tools and representations to provide support for students' thinking. (**Tools and representation**)
10) Effective teachers develop and use sound knowledge as a basis for initiating learning and responding to the mathematical/scientific needs of all their students. (**Teacher knowledge**)

Conclusion

- Pedagogical, content and technical knowledge are important for correct curriculum interpretation and correct selection of pedagogical approaches for effective science and mathematics education.
- Operationally, teachers use their own sets of criteria. Although these may coincide with criteria used by colleagues or with those advocated by the educational establishment, a teacher's own criteria determines his or her professional activities.

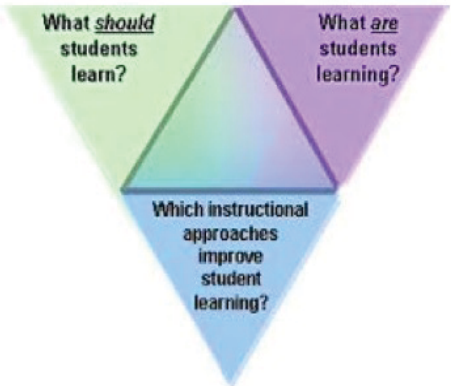
6.5 Appropriate Techniques for improved teaching and learning

SECONDARY SCHOOL SCIENCE CURRICULUM

The secondary school science curriculum aims to:

- engage all students with science as a preparation for life (functional science)
- to inspire and prepare some pupils to continue with science.

Capacity Building Workshop for Science Teachers 8-01-2018 7



Capacity Building Workshop for Science Teachers 8-01-2018 8

Capacity Building Workshop for Science Teachers 8-01-2018 9

Teaching and learning style

Quality of science teaching and learning is inadequate when:

- there is lack of a sufficient number of qualified and dedicated science teachers
- When the balance between the teacher who knows the student or the teacher who knows the subject (knowledge) is lacking.
- The teacher is aware of what works, under what conditions and for whom

Capacity Building Workshop for Science Teachers 8-01-2018 10

CONSISTENT SUPPORT

- About 12 years ago the Secondary Science and Mathematics Teachers' (SESEMAT) Programme was introduced to improve performance in science and mathematics
- need to change the attitude towards doing science subjects among students
  - so far 6000 teachers have been trained
  - The teaching of sciences is inviting and friendly
  - more girls take on the subjects
  - The passing number has risen from 10 to 45%.
  - There is hands-on, which makes it easy and attractive

(*Training can be done and made compulsory-support and supervision-it can be made better- No Sayers will always be there- dedicated teachers are there-see them by their results*)

We think too much about effective methods of teaching and not enough about effective methods of learning

Science Teaching Reference (TR) booklets for the SESEMAT programme for teachers to use to plan their lessons.

Capacity Building Workshop for Science Teachers 8-01-2018 11

PLANNING/TECHNIQUES

- Teaching Reference (TR) booklets –SOW and LP
- Time
- Materials (Resources)-a) Improvisation b) administrative-cost effective/Wastage

- Good Teaching -instruction that leads to effective learning
- *Instructional objectives* are statements of specific observable actions that students should be able to perform if they have mastered the content and skills the Teacher has attempted to teach.
- *At the end of this [course, chapter, week, lesson], the student should be able to **** where ***** is a phrase that begins with an action verb (e.g., *list, calculate, solve, estimate, describe, explain, paraphrase, interpret, predict, model, design, optimize,…*).
- The outcome of the specified action must be directly observable by the teacher.
- Words like "learn," "know," "understand," and "appreciate," while important, do not qualify.
- The more students know what is expected of them, the more likely they will be to meet the expectations

Capacity Building Workshop for Science Teachers 8-01-2018 12

USE ACTIVE LEARNING IN CLASS

- A classroom research study showed that immediately after a lesson students recalled 70% of the information presented in the first ten minutes and only 20% of that from the last ten minutes (McKeachie 1999).
- Students' attention can be maintained throughout a class session by periodically giving them something to do.
- Many different activities can serve this purpose

STUDENTS' INTERESTS…

- Science education must be connected to students' interests and priorities with a greater focus on ideas, evidence and argument.
- That students' interest in science is possible for students to learn science as a story involving people, situations and actions, real world situations that students can engage with
- The science curriculum and assessment MUST take into account the way Science is taught. Changes might include making learning more relevant to real life issues, more debate and research in the classroom
- **Others**
  - **Use of ICT**
  - **Field trips and**
  - **practical 'hands on'**

LEARNING OUTCOMES

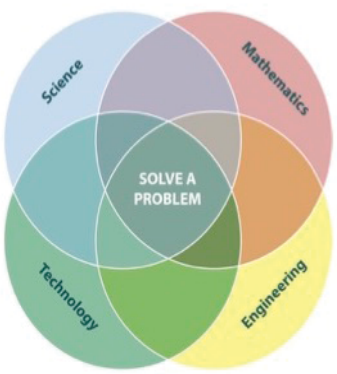
- Strengthen school based support ie CPD by
  - Training workshops (Attitude etc)
  - Mentoring
  - Peer learning
  - Quality teaching and learning materials that use local examples and illustrations.
  - Innovative practices by the teachers (diverse learners)
- Limitations
  - Limited instructional time
  - Teacher absenteeism
  - Low levels of time on a task

Making Teachers accountable

- Leaders emphasize compliance rather than support for teachers.
- A shift from administrators exercising control to offering support
- Promote community support and collaboration at school level
- Engage parents and community leaders

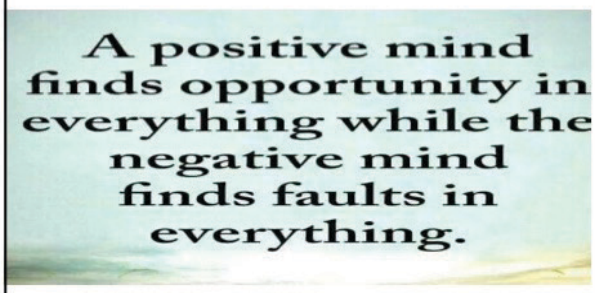
COMPETENCIES BASED CURRICULUM

- A shift to competencies based curriculum that encourages interactive teaching and learning strategies, are intended to be more inclusive and prepare students with transferable competencies to world of work though with academic content bais.
- Will require
  - Less content heavy curriculum
  - Not examination oriented
  - Emphasis on locally available materials
  - Re tooling/skilling teachers etc



QUESTIONS/COMMENT

- **Ugandan Minister blamed science teachers for poor performance of students in the sciences in the country. Why?**
- *"Insanity is doing the same thing over and over again and expect a different result"*
  Albert Einstein



- Opportunities are available to every teacher…

Thank you for listening

6.6 Improved Strategies for Improved Teaching and Learning in Mathematics
By Rev. Fr. Dr. Henry Nsubuga Kiwanuka, Member, IBSP, UMU.

INTRODUCTION Background and Rationale

Mathematics is a foundation that informs our decisions in areas of our lives. Teaching and learning mathematics is at the heart of education. Learning mathematics aims to link school to everyday life, provide skill acquisition, prepare students for the workforce and foster mathematical thinking. Mathematics involves learning to problem-solve, investigate, represent, and communicate mathematical concepts and ideas, and making connections to everyday life.

Hence, mathematics is seen by society as the foundation of scientific and technological knowledge that is vital in social economic development of the nation. Because of this, mathematics is a compulsory subject at both primary and secondary level. It is also a basic entry requirement into courses like medicine, architecture and engineering among other degree courses. Despite the important role that mathematics plays in society, students continue to persistently perform poorly in the subject.

Researchers have found that the problems in the teaching - learning of mathematics are multifaceted and accordingly the solutions require efforts at different levels. The purpose of this paper is to identify some major factors which obstruct the teaching and learning of mathematics and propose possible appropriate strategies to solve these barriers.

FACTORS THAT CONTRIBUTE TO POOR PERFORMANCE IN MATEHMATICS

1. Systematic factors

1.1 School level factors

a) Poor school leadership
b) Lack of frequent supervision and inspection of teachers
c) Lack of learning support
d) Inadequate physical facilities of classrooms, libraries and mathematics laboratories, and existing ones are poorly used.

1.2 Teacher/classroom level factors

a) Improper teaching methods and approaches
   i. Ineffective lecture method turns learners into passive participants
b) Shortage of teaching/learning materials, like mathematics textbooks and relevant teaching/ learning aids
c) Ineffectiveness of mathematics teachers
   i. Inadequate and untrained teachers
   ii. Low level of education<- poor knowledge of mathematics content
   iii. Insufficient teaching experience

iv. Lack of confidence -> inability to teach mathematics
v. Lack of commitment
vi. Difficulty in handling overcrowded mathematics classes: high teacher-student ratio -> teachers fail to pay attention to all students.

d) Teachers' attitudes to teaching -> their perception whether society or students appreciate their work
e) Low teachers' morale and lack of incentives -> poor motivation
f) Teachers' beliefs about mathematics in general and about students' success in mathematics
g) Negative attitudes of non-mathematics teachers tend to discourage students
h) Overload of mathematic syllabus: Undue emphasis on the coverage of mathematics syllabus at the expense of meaning leaning
i) Heavy workload:
i. Teacher turnover and shortage of mathematics teachers (esp. rural schools)
ii. Most mathematics teachers are overloaded with more than 30 lessons a week.
iii. Some teachers have to teach other subjects like physics, chemistry, social science,
iv. Overcrowded classrooms

2. Societal factors

2.1 Students' level factors

a) Negative/poor attitude toward mathematics and lack of interest, fear of mathematics, examination system, and memorization of formulas
b) Mathematics anxiety
i. Difficult subject
ii. Abstract thinking
iii. Logic thinking
iv. Learner's experience of constant failure in mathematics -> discouragement

c) Perception of irrelevance: Limited relevancy between the mathematics contents and day-to-day activities; lack of relationship/connections to practical life with mathematics
d) Gender related
i. stereotyping that mathematics is male domain
ii. Involvement of girls in home duties

e) Lack of seriousness with mathematical work
f) Absenteeism
g) Poor study habits
h) Poor fluency in the language of instruction (English): Inability to read and interpret word problems in mathematics

2.2 Social economic factors

a) Students' parents/guardians education background
   i. High illiteracy
   ii. Little parental support/assistance in their children's homework
   iii. No role models in academic matters
b) Low parental social economic status (SES): sources of income for parents/guardians are farming and meager salary -> inadequate learning resources
c) Poor parental attitude toward mathematics
d) Negativity and reluctance of parents to get involved in the education of their children

3. Pedagogical factors

3.1 Motivation: Teachers don't give proper motivation to the mathematics contents

3.2 Teaching aid: Teachers do not use teaching aids in the classroom except geometric tools in geometry.

3.3 Improper teaching methods and approaches

a) Most teachers follow the lecture or the question-answer method
b) Ineffective lecture method turns learners into passive participants
c) No peer learning
d) Less tendency to do hands on activities

3.4 Classroom assessment

a) Questioning techniques are improper
b) Little homework
c) Little feedback to homework
d) Overcrowded classroom raise problems of assessing students' understanding

RATIONALE

Creating a supportive & engaging classroom environment

> Use student centered teaching method (discovery, problem solving, investigation, group work)

> Support students as they investigate, represent & connect math ideas via discussion in problem solving (Suurtarmm et al., 2015)

> Support unusual ideas and responses (Feldhussen & Treffinger, 1985; Nickerson, 1999; Sternberg & Williams, 1996).

> Make the classroom feel like a community where ideas can be discussed, developed, debated & understood (Bruce, 2007)

> Encourage classroom discussion/dialogue through 'math talk' (Hufferd-Ackles et al, 2004)

STRATEGIES FOR TEACHING & LEARNING MATHEMATICS

Teach for conceptual understanding

> Conceptual understanding is the knowledge of abstract ideas (Rittle-Johnson & Schneider, 2014)

> Teach the concepts behind procedures before or during instruction procedures, not after

> Ask students to justify their processes, facilitate different solution methods and work on unfamiliar problems (Rittle-Johnson & Schneider, 2014)

Teach reasoning skills

> This includes identifying similarities & differences, size or shape

> This helps students' mathematical abilities (Rittle-Johnson & Jordan, 2016)

Promote problem-solving

Problem-solving is all about coming up with original thoughts, not about practicing drills.

> Present complex & rich problems, allowing for multiple entry points, different approaches, scaffolding, & engagement without imposed procedural steps ((Suurtamm, Quigley, & Lazarus, 2015)

> Have students solve open-ended problems for critical thinking (Barwell, 2011; Hoffman &Brahier, 2008; Suurtamm et al., 2015)

> Allow students to

(i) create and solve their own problems (Barwell, 2011)

(ii) to work on problems mirroring authentic real life scenarios (Archbald & Newmann, 1988)

(iii) compare multiple ways to solve problems (Rittle-Johnson & Jordan, 2016)

(iv) critique common mistakes (Rittle-Johnson & Jordan, 2016)

(v) mathematize the world around them (Barwell, 2011)

> Make problem-solving an on-going & continuous part of your classroom.

Encourage creativity in mathematics

Thinking creatively is at the heart of mathematics (Guilford, 1959), but most students have little opportunity to be creative in mathematics (Silver, 1997)

> Give students time to toil with stimulating problems (Burns, 1992)

> Give students time & opportunities to work on problems that require resourcefulness and creativity (Pehkonen, 1997)

Encourage and support collaboration in mathematics

> Provide a classroom environment where students feel comfortable to collaborate, share, explore, and think mathematically

> Collaboration improves self-confidence (Evans & Dion, 1991), feelings of unity (Evans & Dion, 1991), improved satisfaction (Tett & Meyer, 1993) and cohesiveness (Evans & Dion, 1991)

> Collaboration can lead to

(i) strong personal relationship (Hasler-Waters, & Napier, 2002)

(ii) improved problem-solving abilities (Fleming, 2000)

> Use technology to support students' collaboration (Rittle-Johnson & Jordan, 2016)

Provide an inquiry environment

> An inquiry-based learning environment has students take an active role in the learning, and the teacher's role becomes more of a curator

> Students can discover mathematics and make mathematics more than just skills and procedures , and take the role of a mathematician (PRIMAS, 2011)

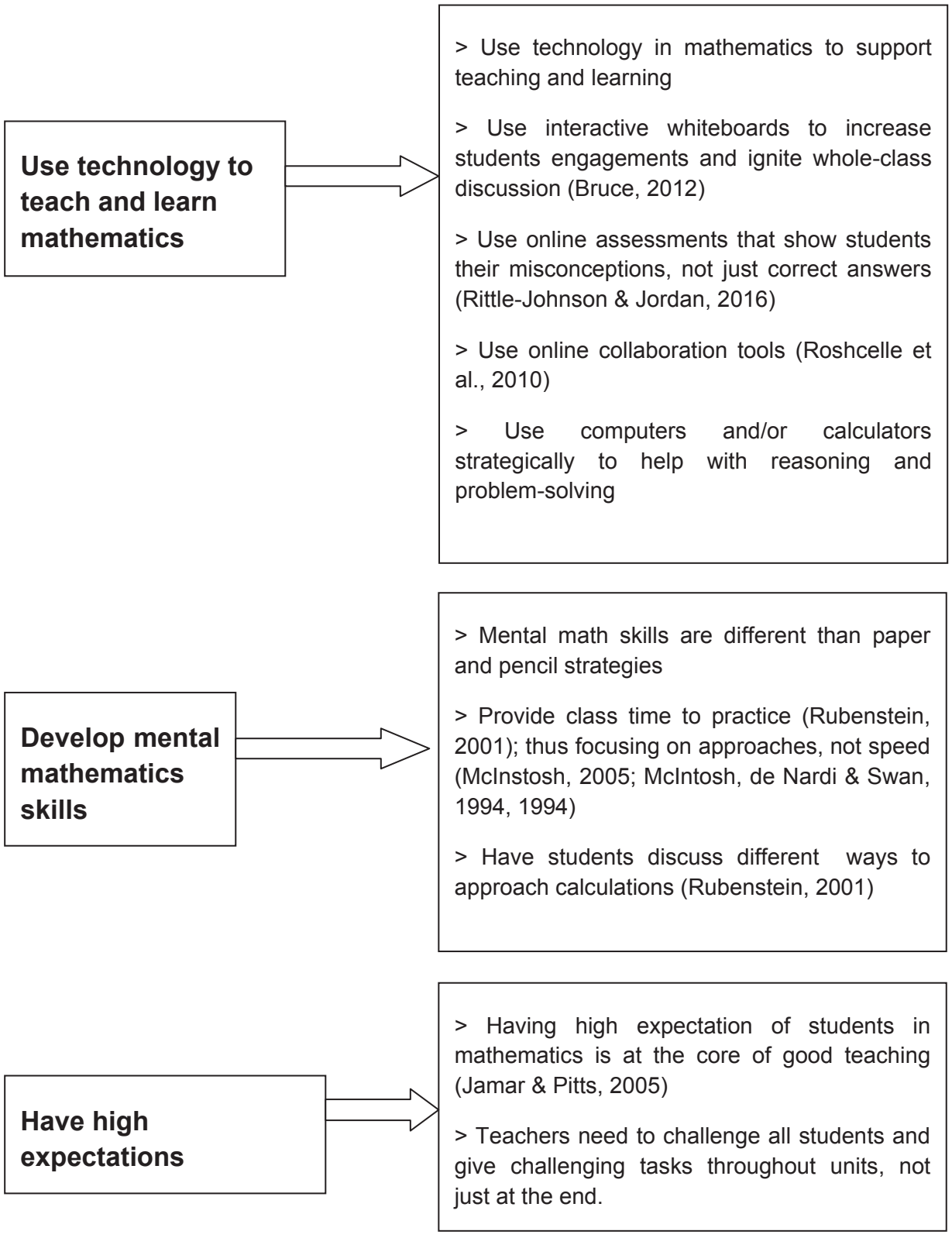
Use Three-part mathematics lesson plan

> The three-part math lesson planning technique is an effective way to teach mathematics curriculum standards, support differentiated learning, create an inclusive classroom, promote problem-solving, and engage students in mathematics (Foote et al., 2014)

> 1st stage: **Launching the task** -> students get excited & cognitively prepared for the lesson

>2nd stage: **Task exploration** -> students explore a mathematics expectation that gives them an opportunity to think, explore and ask questions (Foote et al., 2014)

> 3rd stage: **Summarizing discussion** -> students reflect,


Use technology to teach and learn mathematics
> Use technology in mathematics to support teaching and learning
> Use interactive whiteboards to increase students engagements and ignite whole-class discussion (Bruce, 2012)
> Use online assessments that show students their misconceptions, not just correct answers (Rittle-Johnson & Jordan, 2016)
> Use online collaboration tools (Roshcelle et al., 2010)
> Use computers and/or calculators strategically to help with reasoning and problem-solving
Develop mental mathematics skills
> Mental math skills are different than paper and pencil strategies
> Provide class time to practice (Rubenstein, 2001); thus focusing on approaches, not speed (McInstosh, 2005; McIntosh, de Nardi & Swan, 1994, 1994)
> Have students discuss different ways to approach calculations (Rubenstein, 2001)
Have high expectations
> Having high expectation of students in mathematics is at the core of good teaching (Jamar & Pitts, 2005)
> Teachers need to challenge all students and give challenging tasks throughout units, not just at the end.

6.7 Methods of Simplification of Subjects for Learners

CAPACITY BUILDING WORKSHOP FOR SCIENCE TEACHERS FROM POORLY PERFORMING SCHOOLS.

METHODS OF SIMPLIFICATION OF SUBJECTS FOR LEARNERS; THE CASE OF CHEMISTRY SUBJECT.

Presenter:

- Mpamizo Gonzaga – Education coordinator Uganda royal society of Chemistry (URSC) centre Bukinda and a teacher of Chemistry / Physics.

Introduction:

The challenges in teaching/learning sciences include;

- Inadequate facilities.
- large class sizes.
- few science teachers.
- low pay.
- lack of trained laboratory technicians
- etc.

Pivotal role of teachers.

- Applying methods of teaching that lure learners to sciences.

Work at Bukinda, one of our URSC centres.

- We are with no doubt convinced that we need to teach by doing practical.
- We have heard engagements with teachers and learners through our work of promoting chemistry for over 12 years and we are stuck to that conviction.

This makes chemistry

- Fun
- Simple
- Clever
- Career giving.

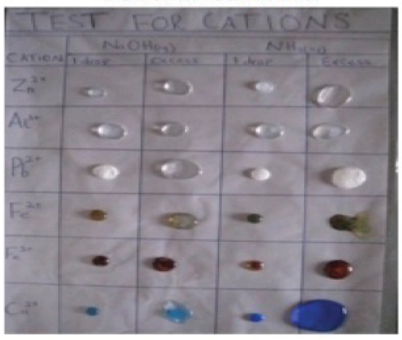
HOW?

- Guide learners in doing simple test tube gas preparations.
- Hydrogen, oxygen, carbon dioxide and other friendly gases can be prepared this way by learners in groups and content can be developed from this. The method is simple, saves time, uses cheap apparatus and is learner centered.

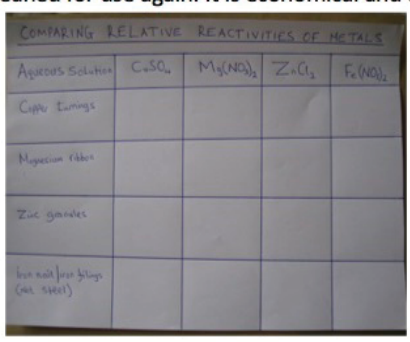
The method is

- Simple
- Saves time
- Uses cheap apparatus
- Is learner centred.

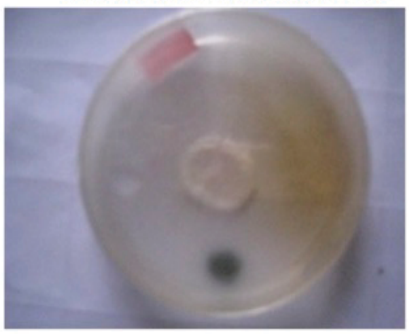
- Use of plastic sheets for cheap and easy introduction of qualitative analysis and as a general strategy for comparing relative reactivity of metal elements. Look at this.



- You design a table on a piece of paper and insert it in a transparent plastic sheet. The sheet can be cleaned for use again. It is economical and clear.



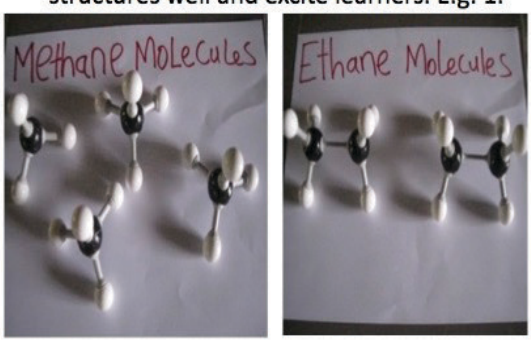
- Petri dish technique for preparation of dangerous / poisonous gases such as chlorine, nitrogen dioxide, sulphur dioxide, etc. e.g



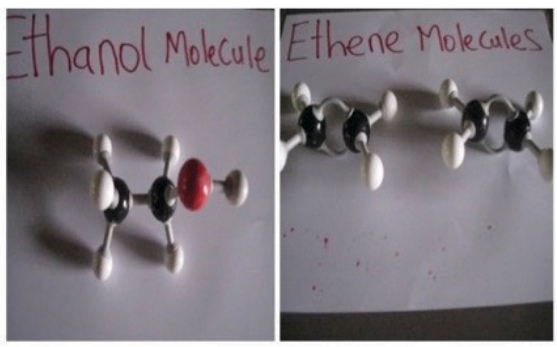
The picture above shows preparation of sulphur dioxide gas and demonstrating its properties.

- Sodium sulphite was placed at the centre.
- Acidified potassium permanganate, acidified potassium dichromate, concentrated nitric acid and wet blue/ red litmus paper are placed in the sides.
- Concentrated sulphuric acid(about 2 drops) is dropped onto the sulphite and the lid/ cover placed immediately. Observe and try to explain the reactions.

➢ Use of molymod models in teaching organic chemistry. These demonstrate organic structures well and excite learners. E.g. 1.



2.



Other methods of simplifying chemistry;

➢ Integrating DVD demonstrations into lessons. These are exciting and exposing.

➢ Industrial visits and field trips e.g to;

- Jinja textiles,Rugazi sugar, Kilembe copper mines, Kasese cobalt, tea growing and processing in Kyamuhunga, Hima cement factory, Katwe salt mining

These;

- Connect theory to practical
- Are relevant to the science on our syllabus.

➢ Divide up the mole concept.

Moles kill chemistry. Learners will confess that moles put them off. In S.2 learners can do simple calculations on;

- Empirical formula.
- Molecular formula.
- Percentage composition.
- Then the rest can be handled in S.3 and onwards when skills in mathematics have improved.

➢ Revise promotions on averages.

- 80% in arts compensates for 30% in sciences and a student is promoted to the next class.
- Wise school have an average for sciences as a measure to improve student performance.

Conclusion:

- Managers of education, teachers and learners must swiftly go the practical way and invest heavily in science and technology for our country Uganda to compete in the developing world.

THE END:

6.8 Guidelines to conducting science practicals: By: Emmy Semuwemba, SESEMAT, Trainer

Guidelines to conducting science practicals for effective learning in science and mathematics education

Background

- In today's classroom, the students have diverse backgrounds and learning styles which affect their ability to acquire knowledge.
- Teachers need to utilize learner centered approaches, methods, techniques and tools that enable them to build their own understanding through real world applications and interactions with their peers to ensure lifelong learning skills

Background

- It must cater for 3 domains (3Hs)
  - Cognitive aspects (Head) e.g. knowledge, comprehension analysis, etc.
  - Psychomotor (Hands); manual, manipulative - physical skills
  - Affective (Heart); feelings/attitude-Enjoyment and liking

This can be achieved through **well planned** practical lessons

Importance of practical lessons /activities

- A practical approach involves learners,
- Improves their observational , recording, and analytical skills in handling scientific and mathematical concepts.
- This motivates them, arouses their curiosity, and promotes active learning as opposed to rote learning.

Practicals can be:

- **INDIVIDUAL/CLASS PRACTICAL WORK;** these boost the learners' imagination, curiosity, reasoning, as well as ability to follow instructions.
- **STUDY TOURS/FIELD TRIPS**
  - Involves studying away from usual place of work e.g. market, forest, play ground, etc.
  - Provides learning experiences that can not be accomplished in class.
  - Involves visual, auditory, and other senses (is kinesthetic)

- **DEMONSTRATIONS;** utilize visual and auditory aspects ,may be used to prepare learners for work in the lab.
- **PROJECT**
  - Is a way that is skills based and involves a multi sensory approach
  - Caters for learners with a wide range of individual differences, capabilities and backgrounds
  - Develops many skills e.g. reasoning, communication, presentation, improvisation etc

- An effective practical lesson must get students thinking, should allow them to interact, ask questions, tap into their background knowledge, and build new skills.

Guidelines to Planning an effective practical should involve;

- **Analyzing**/internalization of the concept and content **in time**
- **Simplifying** the content to the level of the learners
- **Customizing/relating** the practical to real life situations
- **Selecting** simple and appropriate apparatus and setting instructions/questions **in time**
- **Building on** learners own knowledge for them to learn, unlearn, and construct knowledge
- Creating an **environment** (classroom) that fosters Learning ***(taking care of the class size)***
- **Facilitating**/mentoring instead of giving knowledge&/lecturing

Customize/relate practical to real life example 1

Materials : plastic bottle, straws, balloons

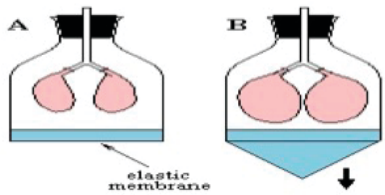
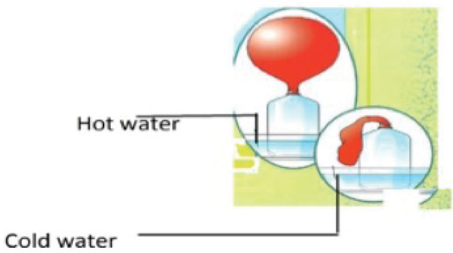


Figure 19 - A lung model.

Customize/relate practical to real life example. 2

Expansion of air



Example 3, Effect of impurities on density

- **3. Experiment to investigate the effect of impurities on density**
- **Materials required**
- An egg
- Water
- Salt
- Beaker (or transparent container e.g. glass)
- **Procedure**
- a) Fill the beaker half-way with clean water
- b) Gently drop the egg in the water
- c) What do you observe?
- d) Add about 200g of salt in the water and stir
- e) What do you observe?
- f) Explain your observation

Learners will be more involved if;

Guided into formulating;

- Assumptions/predictions/Hypothesis

Example

1.Which is heavier? A cup of table salt or a cup of table sugar?

2.What would happen if a beaker is inverted on a burning candle ?

These aspects and others will enable learners to ask questions in the classroom.

Evidences Of a good practical

It cab be a good practical lesson if...

- ✓ Learners are active and in a continuous dialogue with each other, and the teacher
- ✓ Learners are constructing knowledge, not being fed
- ✓ Truth is discovered, not delivered
- ✓ Teacher "leads from behind" or "moves with the learners"
- ✓ Teacher functions as a facilitator/mentor instead of lecturer
- ✓ Questions are answered with explanations or questions, not simply "yes" or "no"

Evidence Of a good practical

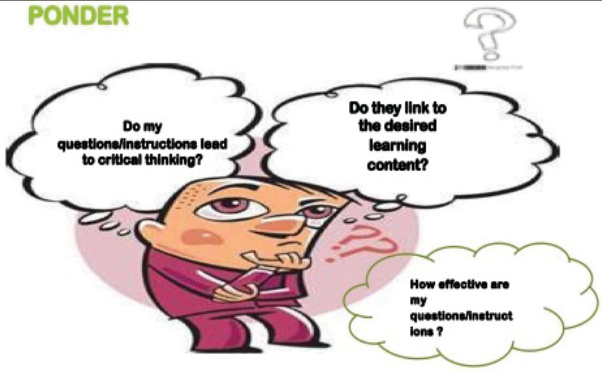
Do we see learners asking questions and offering explanations during the practical

"That's a good practical lesson."

It's usually has questions /instruction that stimulate thinking and reasoning because they can't answer quickly and easily.

Indeed, "good" questions and instruction are ones that generally need thinking about.

PONDER



Thank for your attention

Ssemuwemba Emmy