

**INSPIRING SCIENCE EDUCATION FOR GIRLS USING ICT
SCIENCE TEACHER TRAINING WORKSHOP
HELD AT DABANI GIRLS SECONDARY SCHOOL
BUSIA – UGANDA**

(29TH JAN – 2ND FEB) 2007



Figure 1: Dabani Girls Secondary School

Day 1: Monday 29th Jan 2007

Activities of the day

Time	Activity	Lead by Whom
8:30 -9:30 AM	<ul style="list-style-type: none"> • Welcome note by the Head teacher of Dabani Girls. • Collaborative Introductions. • Training Approach for the Workshop 	Head teacher, Dabani Girls School -Facilitators - Kakinda Daniel
9.30 – 10:30 AM	Challenges of Teaching & Learning Science (Teachers' perspective)	Lawrence Ssenkubuge
10:30 -11:00 AM	HEALTH BREAK	
11:00 -12:00 PM	Challenges of learning sciences by girls (Student's perspective)	Joyce Nanoozi (girl-child)
12:00 – 1:00 PM	Presentation : "How ICT can	

	address some of the challenges of teaching & learning Science	Kakinda Daniel
1.30 -2:00 PM	LUNCH	
2:00 – 3:40 PM	Presentation: Integrating ICT in the teaching of Sciences & Mathematics.	Kakinda Daniel.
3:40 -4:00 PM	BREAK	
4:00 – 11:00 PM	Participants' reflections on the experiment.	

Welcome Address by Head teacher of Dabani Girls.

The Head teacher of the host school, Dabani Girls was represented by the 2nd Deputy Head teacher, Sr. Stella Tino.

She thanked SchoolNet Uganda for not only choosing Dabani Girls as one of the project school for the “Inspiring Science Education for Girls using ICT” but for also choosing it to host the 5-day workshop for the science teacher for schools in Busia District. She promised the participants that the school will do its best to provide an enabling environment for the workshop.

She thanked SchoolNet Uganda for its innovations and pledged continued co-operation from Dabani Girls School.

Collaborative Introductions

As a way of creating an inductive workshop environment, each participant was asked to pair and interact with a new friend. Thereafter, each participant was to introduce the new friend. The introduction included;

- Names
- Subjects
- School
- Any responsibility
- One unique thing about the new friend
- Hopes out of the workshop
- Fears for the workshop.

Hopes

Below are some of the things participants hoped to get from the workshop.

- Improved computer skills
- Discovering how to use the ICT skills for better teaching of science
- Making new friends
- Networking
- Improved awareness of the potential of ICT in Education
- Exhaustive coverage of the programme
- Some of the “seeds of change” might fall on fertile soil so that ICT & science can grow.

- ICT as a tool for teaching real or a myth?
- Learning more/new things
- Empowering science teachers to teach girls in sciences in a better way using ICT.
- Every one invited turns up
- New people, New attitudes

Fears

Participants expressed the following fears:

- Poor turn up
- Erratic power
- Poor weather
- Not staying up to the end due to other schedules
- Poor time management
- Technophobia on the side of trainees
- Few equipments/few machines
- Transferability of skills learned
- Language barrier if communicating with people in the community.

Reactions to the fears.

- The school had two stand-by generators in case of any power cuts.
- Participants were encouraged to invite other teachers to replace those who had not turned up for the workshop.

Ground rules

Participants agreed on the following ground rules.

- Phones in silent mode.
- Stick to the programme and keep time.
- All of us know something so we must share (experience, skills, and feelings).
- Recognise and respect other's opinions and feelings.
- Attend regularly.
- Shed off our titles and be equal.
- Open and close the day with a prayer.
- Be camera friendly.

Training Approach for the Workshop

Participants were given a brief about the training approach which was to be used in the workshop. A holistic approach was to be used in the training. This approach would involve;

- Creating awareness among teachers why & how ICT can enhance teaching and learning of science through presentations by trainers and other visiting educators.
- Developing teachers' ICT skills.
- Changing teachers' attitudes towards ICT through other teachers' personal testimonies.
- Increasing teachers' self esteem and presentation skills by providing opportunities for the learners to present their work to the rest of the group.
- Creating a network of teachers who can support each other even after the workshop by encouraging peer-peer learning and support during and between trainings.
- Training teachers to use new tools for teaching beyond the chalk & the blackboard e.g. the LCD projector, digital camera and video camera.
- Provide teachers with training materials.
- Learning in context by requiring the teachers to do project work related to their subject areas, e.g. asking them to prepare a PowerPoint presentation of how they would teach a certain unit in their curriculum.

Challenges of teaching and learning science

Through a brainstorming session facilitated by Lawrence Ssenkubuge, the workshop participants identified the following as the challenges in the teaching and learning of science in Uganda secondary schools..

- Insufficient or no effort to relate science to reality/real life.
- Stereotyping – Girls are good at Arts and boys are good at sciences.
- Many science concepts are abstract. They are difficult to visualize and with no concrete examples teachers can give to the learners.
- Lack of qualified and small number of science teachers. Some schools are forced on taking up unqualified teachers.
- Students' fear of sciences because of the calculations involved.
- At times overemphasizing of maths leads to reduction of interest.
- Lack of career guidance.
- Lack of sufficient drive or role models in the science area to inspire others to do sciences.
- Lack of motivation for the teachers (e.g. remuneration, professional development & exposure).
- Lack of professional development and in-service training for teachers.
- Lack of science laboratories, chemicals & equipment.
- Self pity and discouraging remarks from peers and relatives.
- Production of students who know scientific concepts without having a scientific mind or having scientific literacy.

Challenges faced by the girl-child in the learning of sciences. (Girl-child perspective)

Joyce Nanoozi, a female student of Makerere College School, offering PCB/M (Physics, Chemistry, Biology /Mathematics) addressed the workshop participants. She mentioned the following as some of the challenges faced by girls in the learning of science.

- Failure to visualize abstract concepts.
- Loss of interest in science due to failure to see the application of science concepts in real life.
- Lack of encouragement and discouraging remarks from parents, teachers and boys.
- Self pity e.g. Some girls taking Biology don't want to dissect frogs.
- Lack of female role models in Science.
- Small number of female students in science classes.
- Lack of self-esteem.
- Boring teaching methods used by some of the teachers.
- Unwillingness to put in enough effort and time to understand science concepts.
- Girls are easily discouraged by low marks in test and examinations.

Joyce Nannozi mentioned some topics which are difficult to study. These included blackbody radiation in Physics, heat changes in Chemistry and endocrine system in Biology.

She suggested the use of role models, encouragement and exposure to study techniques as some of the strategies of encouraging more girls to study sciences.

Presentation: How ICT can address some of the challenges of teaching & learning Science?

In his presentation, Kakinda Daniel noted that whereas there is no single silver bullet which can be used to address all the above challenges of teaching and learning of Science, appropriate use of Information Communication Technology (ICT) combined with teacher pedagogical professional development provides an opportunity of addressing some of the above challenges.

- (i) Lack or inadequate instructional materials like books, equipment and chemicals can be addressed through the use of electronic books, virtual science labs, simulations and video clips.
- (ii) Abstract science concepts can easily be explained and visualized through the uses of animations and simulations.
- (iii) Using Video clips, the external environment can be brought into the classroom helping to relate Science to the daily life experiences of the learners.

- (iv) Young people naturally love technology. Using ICT to deliver the science curriculum makes science teaching interesting and motivating.
- (v) Providing teachers with pedagogical professional development and modern tools of teaching beyond the chalk-and-blackboard makes teaching easier and motivating, helping teachers develop a positive attitude towards work.

Kakinda informed participants that four organizations; Digital Links (UK), Barclays Bank, SchoolNet Uganda and Ministry of Education and Sports had partnered to pilot a project called “Inspiring Science Education for Girls Using ICT”.

The project activities included:

- Provision of affordable computers to schools with the majority beneficiaries as girls schools.
- Training of teachers in how to use ICT to enhance the teaching and learning process in science.
- Training of teachers to identify and create digital multimedia educational content relevant to the Uganda science curriculum.
- Encouraging active participation of girls in science fairs.
- Training of students how to use ICT to enhance the learning of sciences through organizing Science-ICT holiday camps for the girl-child.

Presentation: Integrating ICT in the teaching of Sciences & Mathematics.

Kakinda illustrated how ICT can be integrated in the teaching of Mathematics, Physics, Biology and Chemistry using a combination of e-books, animations, simulations and video clips.

- (i) Mathematics examples
 - Supporting Active learning in Mathematics – Projectiles
<http://phet.colorado.edu/web-pages/simulations-base.html>
- (ii) Physics examples
 - Online Physics books
 - Interactive Physics book
<http://www.walter-fendt.de/ph11e/>
 - Physics Educational Technology
<http://www.colorado.edu/physics/phet/web-pages/index.html>
 - Physics and Chemistry
<http://www.physchem.co.za>
 - Virtual Physics Experiments using simulations from the SimLab
<http://www.saintmarys.edu/~rtarara/DOWNLOADS.html>
 - Visualization of abstract concepts
 - Photoelectric effect
<http://phet.colorado.edu/web-pages/simulations-base.html>

- Resonance in RCL a.c Series Circuit
<http://www.ngsir.netfirms.com/englishhtm/RLC.htm>

- Access to past papers
- Relating scientific concept to the real world
 - Vibrations in stretched strings (video clips)
 - Pressure in liquids and atmospheric pressure (video clips)
 - Strength of materials – struts and ties (video clips)
- Using simulation to address shortage of equipment – Geometric optics
<http://phet.colorado.edu/web-pages/simulations-base.html>

(iii) Biology examples

- Evolution
 - Online book (e-books)
<http://evolution.berkeley.edu>
 - Comparative Taxonomy using the e-Skeleton project
www.eskeleton.org
- Blood circulation illustrated using both an animation and a simulation.
- Online Biology books
<http://ridge.icu.ac.jp/biobk/biobooktoc.html>
- Interactive Biology Quizzes
http://www.fed.cuhk.edu.hk/~johnson/interactive_MC/eng_selection.html
- Ecology : Adaptation in plants (video clips)
- Bringing real life examples in the classroom – Fish Aquarium (video clip)
- Malaria- Life cycle of Plasmodium (animation)
<http://highered.mcgraw-hill.com/sites/dl/free/0072437316/120060/ravenanimation.html>

(iv) Chemistry examples

- Online Chemistry Books (e-books)
www.physchem.co.za/
www.preparatorychemistry.com/Bishop_Home.htm
- Periodicity of Atomic properties using the Interactive Periodic Library
www.boolean.ca/perlib/
- Visualization of abstract concepts (Rutherford's alpha-scattering experiment and Le Chatelier's principle using animations available at
<http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/flash.mhtml>
- Virtual Chemistry laboratory – The InYdium Project
<http://www.chemcollective.org/applets/vlab.php>
- Audio and visual enhancement of content (video clip showing laboratory preparation of oxygen from hydrogen peroxide)
- Application of chemistry (video clip showing extraction of insecticides from lemon peels.

Day 1: Participants' Reflections

Below are some of the participants' reflections for Day 1

- It is much easier to teach sciences with ICT.
- Abstract science concepts can be visualized.
- It is possible to convince everyone of the possibility of using ICT to enhance the teaching and learning of science.
- I have been refreshed of the students' perspective of learning.
- There are many reference science e-books.
- By using multimedia, ICT can enhance the teaching process.
- In ICT, you can still achieve a lot even without Internet connection.
- As an Artist, if I had been taught using ICT, I would have loved Mathematics.

Day 2: Tuesday 30th Jan 2007

Activities of the day

Time	Activity	Lead by Whom
8:30 -10:30 AM	Hands-on: Physics Virtual Experiment – Determination of the focal length of a converging lens.	- Kakinda Daniel - Participants
10:30 -11:00 AM		
11:00 -12:30 PM	Hands-on: Chemistry Virtual Experiment –.Acid-Base titration	- Kizza Vincent - Participants
1.30 -2:00 PM	LUNCH	
2:00 – 3:40 PM	Hands-on : Biology Virtual Experiment	- Ssenkunja John - Participants
3:40 -4:00 PM	BREAK	
4:00 – 5:00 PM	Exploring the science resources and navigating through the simulations.	- Participants

Hands-on with the virtual experiments

(a) Physics Virtual Practical (see details in Appendix 2).

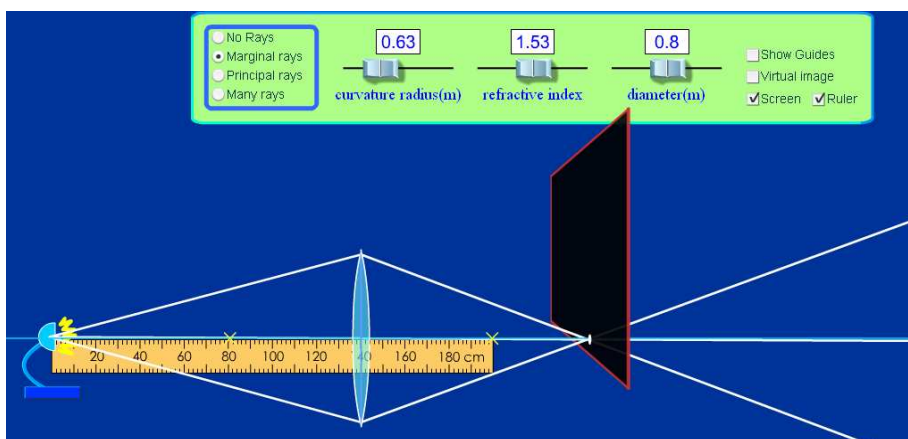


Fig 2: Using a simulation to determine the focal length of a converging lens.

Kakinda gave the participants an introduction to the Geometrical optics simulation available at:

<http://phet.colorado.edu/web-pages/simulations-base.html>

Participants were asked to determine the focal length of a converging lens using the geometric optics simulation. (See appendix 2)



Fig 3: Participants doing a Physics practical.

The purpose of this activity was to give workshop participants an opportunity to experience what is involved in doing a virtual Physics experiment and how such an experiment is integrated in the current Uganda Physics curriculum.

Participants were provided with squared paper, rulers and pencils. They had to record their measurements, plot graphs, draw the best fit graph and determine the slope of the graph

Participants' reflections on the Physics Virtual Practical

Participants made the following reflections regarding their experience with the Physics virtual experiment.

- It is possible to do Physics practical even in the absence of physical apparatus.
- It is possible to vary the focal length of the virtual lens by varying its refractive index and its radii of curvature.
- It is time saving. You don't need to move apparatus from the store and arrange it on the table.
- Access to a lens whose characteristics/parameters can be varied
- Virtual experiments are easier and motivating and cost effective.
- Virtual experiments take a shorter time
- Like real experiments, virtual experiments require skills. You need even to be computer literate.
- There are no breakages and losses of the apparatus.

(b) Virtual Chemistry Laboratory

<http://www.chemcollective.org/applets/vlab.php>

The screenshot displays the IrYdium Chemistry Lab interface. On the left, the 'Stockroom Explorer' lists various chemical solutions and indicators. The main 'Workbench 1' area shows a virtual lab setup with a 50mL buret, a 1M NaOH flask, a disposable pipet, and a 10M HCl flask. On the right, the 'Solution Info' panel displays a bar chart of log molarity and a table of species and molarities. At the bottom right, a pH meter shows a reading of 6.99.

Species	Molarity
H ⁺	1.014e-7
OH ⁻	9.957e-8
PhenolphthaleinH	1.998e-6
Phenolphthalein	1.826e-9

Fig 4: Exploring the virtual chemistry lab

Participants explored the features of the Chemistry virtual lab facilitated by Kizza Vincent.

Thereafter, participants did a strong acid- strong base titration using the virtual chemistry lab.

(See Appendix 3)

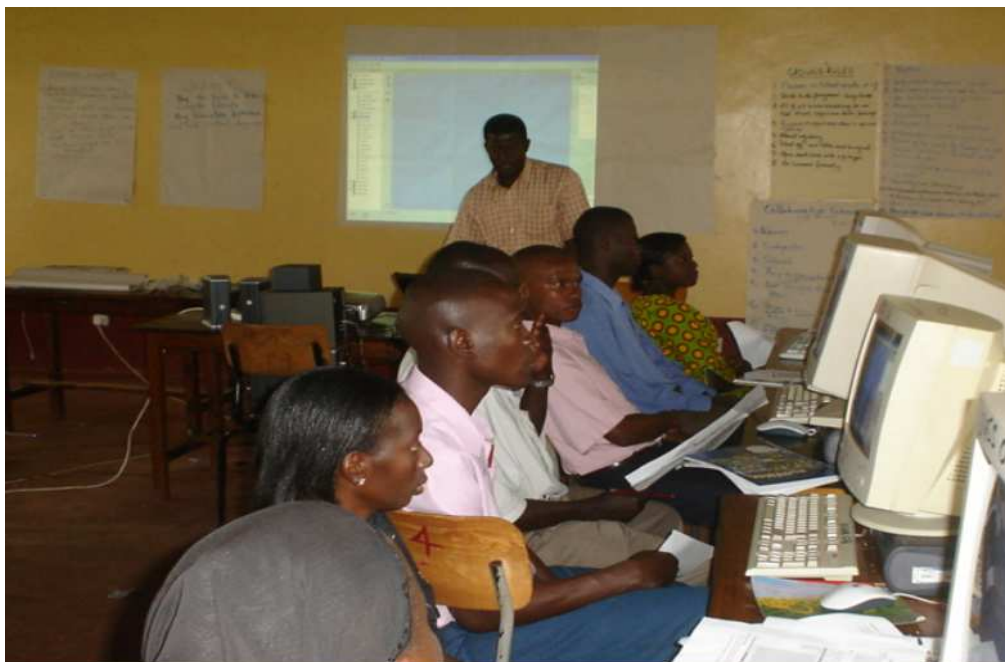


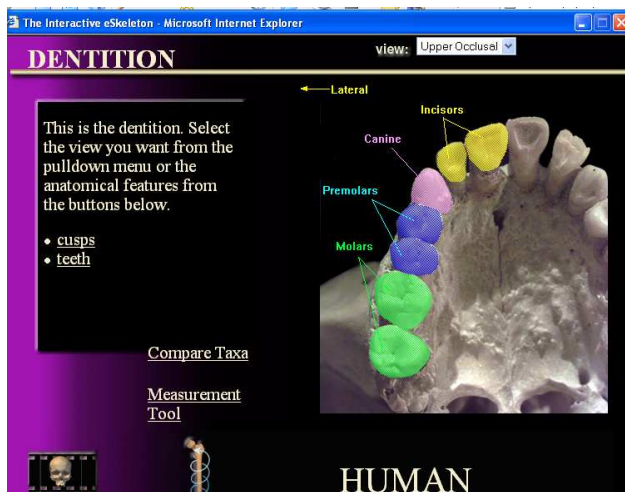
Fig 5: Teachers doing a virtual chemistry practical

The participants made the following remarks regarding their experience with the virtual chemistry lab.

- Accurate: values of titre obtained by titration are the same as those obtained by calculations.
- Cost effective
- Unlimited access to chemicals
- Chemicals don't expire
- Helps to avoid contact with irritating and dangerous chemicals.

Biology Practical

Participants were introduced to the e-skeletons project (www.eskeleton.org), The facilitator, John Ssenkunja gave participants a walk-through the e-Skeleton project.



The facilitator illustrated the use of the *Measuring tool* and *Comparative Taxa* using the dentition of human, chimpanzee and gorilla skeletons.

Fig 6: Dentition of a Human

Participants were given an exercise where they were required to do comparative taxonomy of primates using brain size.

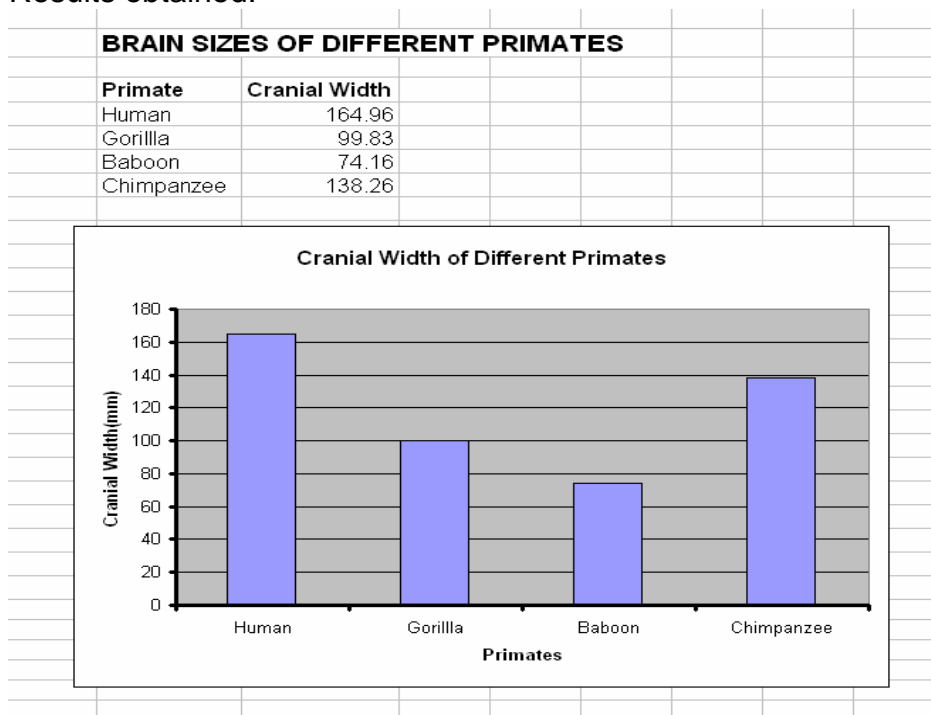
Exercise: See Appendix 4

Using the eSkeleton project for comparative taxonomy



Fig 7: Participants measuring the brain size

Results obtained:



From the graph, the Chimpanzee has a brain size closet to that of the human.

Wednesday 31st Jan 2007

Activities of the day

Time	Activity	Lead by Whom
8:30 -10:30 AM	View of a video tape of the National Science fair 2006.	Participants
10:30 -11:00 AM		
11:00 -12:30 PM	Discussion about the rationale & benefits of actively involving students in science fairs	Kakinda Daniel
1.30 -2:00 PM	LUNCH	
2:00 – 3:40 PM	Presentation on SESEMAT & Minds-on activities for participants	John Ssemondo
3:40 -4:00 PM	BREAK	
3:00 – 4:00 PM	Participants' presentations and harmonising.	John Ssemondo Participants

Science Fair: Minds-On Activity

Participants were given the opportunity of viewing a recording of the Uganda National Science fair 2006. After watching, the video tape, participants were asked to reflect on the following issues.

- (i) Which of the challenges of teaching science do the Science fairs address?
- (ii) How do science fairs address these challenges?
- (iii) Why should we actively involve our students in science fairs both at school level and at national level?
- (iv) How can ICT be used to increase the active engagement of students in the science fairs?

Each participant was given an opportunity to present his/her response to the rest of the group.

Participants' responses to the issues related to the science fairs

- (i) *Which of the challenges of teaching science do the Science fairs address?*
 - Lack of chemicals/instructional materials.
 - Stereo type of thinking that sciences are for men.
 - Lack of interest in science.
 - Failure to relate science concepts to real life.
 - Lack of peer-learning and peer-teaching.
 - Lack of career guidance.
 - Lack of practical lessons due to low motivation for teachers.
 - Failure to use the most effective methods of teaching.
 - Lack of interest in sciences by students due to abstract teaching.
 - Lack of qualified teachers in under- resourced schools.
 - Lack of active engagement of students in science activities.
 - Lack of innovation and creativity.
- (ii) *How do science fairs address these challenges?*
 - Bring science to reality.
 - Help to develop interest in science.
 - Encourages participants to use local materials. Materials from the environment can be used as instructional materials.
 - Actively involving the students. Students produce biogas, insecticides etc. It promotes learning.
 - Encourages creativity, innovation and improvising.
 - Students apply science concepts in daily life.
 - People enjoy application of science.
 - Transfer of science concepts from theory into practice.
 - An opportunity to learn from peers.

- Removes stereo-type of thinking that sciences are for men through the participation of girls in the science fairs.
- Career guidance by seeing & participation.
- Motivation as a result of an opportunity of seeing new places.
- Exchange of knowledge and getting new friends.
- Involves all aspects of teaching and learning. Students have to do research, team work and collaboration.
- Students learn better as the students explain their project to the public. The best way of learning something is by teaching it to another person.
- Students present what they have done.
- Disadvantaged students have a chance to learn from other schools and other students.
- Students are actively involved in generating ideas for the science fair, setting up the exhibition and explaining science concepts to peers and the general public.

(iii) *Why should we actively involve our students in science fair both at school level and at national level?*

- Motivates and increases students' interest. Once motivated they learn more easily.
- Students realize their potential as they develop and exhibit their project.
- Encourages competition and collaboration among students. Students collaborate as they work in their teams but there is also competition among the teams.
- Develops interest in students and this will increase the number of students taking sciences.
- Participation at national science fairs, gives students an opportunity of seeing student role models.
- Enable students to apply the scientific concepts learnt in class to daily life and can help to reduce the cost of living.
- Students can appreciate the uses of different plants/trees in nature and encourages them to conserve them.
- Increases in students self esteem and confidence.
- Increases students' exposure.
- Helps students develop communication skills.
- Helps students realize the importance of the environment and they become more concerned about environmental conservation.
- Science fairs promote inter-school cooperation
- Helps students to recognize the contribution of science to society.
- Generating new ideas for employment and making money.
- Make students realise alternatives in their environment e.g. extracting insecticides from plants in their environment like sisal as opposed to buying insecticides from the shops.

(iv) *How can ICT be used to increase the active engagement/participation of students in the science fairs?*

- More cost effective. Some of the parts of the Science fair could be shown virtually. E.g. Photographs can be used to show some of the stages involved in mushroom growing.
- Photographs and a video of the science fair can be taken. The video can be watched by students after the fair. Students who missed the science fair can benefit by watching the video. Teachers can also use the video as an instructional material. This will encourage more students to participate in future science fairs.
- ICTs can be used to sell the idea of science fairs to schools. This will motivate more schools to involve their students in science fairs.
- By showing students, a video of a science fair, more will be motivated to participate in subsequent science fairs.

Participants were informed that Dubani Girls had scheduled a school science fair on Saturday 17th March 2007. On behalf of the “Inspiring Science Education for Girls with ICT” project partners, Kakinda promised a prize of a computer to each of the best O’Level and A’Level best exhibitor(s).

Presentation on SESEMAT

This presentation was made by John Ssemondo, formerly a Physics and Chemistry teacher at Mengo Senior School and now one of the national SESEMAT (Secondary Science and Mathematics Project) teacher trainers.



Fig 8: Presentation on SESEMAT by John Ssemondo

Ssemondo outlined the objectives of the session as to enable participants to:

- Identify factors that negatively affect the learners' performance in science and mathematics and strategies to overcome them.
- Identify factors that negatively affect the teachers' performance in science and mathematics and strategies to overcome them.
- Identify ways of shifting from teacher-centered pedagogy to learner-centred pedagogy.

(a) Reflection on the Current Situation in secondary schools

Participants were divided into two groups. Each group was given 20 min and some issues to reflect on. Participants in each group were asked to choose a chairperson and a secretary. Each group later presented what they had discussed at the plenary.

Group 1: Members of this group were asked to discuss the following:

- What methods do teachers use to teach Science and Mathematics?
- What factors affect day to day teachers' performance?
- How do teachers do their routine work?
- How do teachers look at their professional development and growth?

Group 2: Members of this group were asked to discuss the following:

- How do teachers interact with the learners inside and outside the classroom?
- What new reforms have taken place in the Uganda educational system?
- What challenges are the Science and Mathematics teachers likely to face as a result of these educational reforms?

(b) Presentations by Participants

This plenary session was moderated by one of the participants, Apora Patrick, a biology teacher at Masaba College Busia.

Group 1 Presentation

- (i) Methods used by teachers to teach Science and Mathematics include:
- Experimentation
 - Guided discovery
 - Discussions
 - Demonstrations
 - Talk & Chalk
 - Questions & Answers

(ii) Factors that affect day-to-day performance of teachers include:

- Inadequate teaching and learning resources.
- Available but inaccessible instructional materials.
- Low motivation for teachers (monetary & non-monetary) resulting in teachers not working to their full capacity.
- Lack of innovation and creativity on the part of the teachers.
- Lack of team work. Most teachers work in isolation. There is no peer-to-peer learning and sharing of knowledge and experiences.
- Large classes which not only make teaching difficult but also promote class indiscipline.
- Interruptions from many extra-curriculum activities.
- Indiscipline of students, sometime demanding for teacher transfer.
- Abrupt Workshops by the Ministry of Education and Sports.

(iii) How teachers do their routine work.

Teachers' routine work is guided by the school annual work plan, school time-table and the responsibilities assigned by the school to the individual teachers e.g. Director of Studies, Head of Department and Master on duty.

(iv) Teachers' attitude towards professional development and growth.

- Most teachers view professional Development positively and achieve it through going for further studies, attending In-Service workshops and seminars.
- A few teachers don't go for further studies for fear to be deleted from the Government pay-roll.
- Some of the Government policies e.g. the current ban on the recruitment of teachers, contribute a lot to the negative attitude of teachers towards professional development.

Group II Presentation

(i) How teachers interact with the learners inside and outside the classroom.

- Inside the classroom, teachers teach students, engage in discussions with students and mark student exercises, tests and exams.
- Outside the classroom, teachers co-ordinated extra curricular activities like clubs and sports, do counselling and discipline students. However, some teachers have no business with students outside class leaving them on their own.

- (ii) New reforms have taken place in the Uganda educational system.
- Science subjects have been made compulsory for all O'Level students effective 2006.
 - Information Communication Technology (ICT) programs have been introduced at all levels of the Uganda Education System.
 - Universal Primary Education (UPE) was introduced in 1997 and Universal Secondary Education (USE) in 2007.
 - Curriculum review where the total number of subjects has been reduced from 44 to 22 and each school required only to offer a maximum of 14 subjects.
 - Emphasis on the Girl-Child at all levels of the education system.
- (iii) Challenges that the Science and Mathematics teachers are likely to face as a result of these educational reforms.

As a result of the introduction of Universal Secondary Education (USE), the teachers will most likely to face the following challenges:

- Insufficient teaching and learning resources. More students will be using the few books available in schools.
- Long- working hours for the teachers. Teachers will have to spend more time outside class trying to help the slow-learners.
- High student to teacher ratio. Each teacher will be in charge of many more students.
- Loss of interest by teachers in the profession due to lack of motivation.

(c) Harmonizing by the session facilitator – Mr. John Ssemondo

Ssemondo informed participants, that the Ministry Of Education and Sports with the support of the Japanese Government had started a Secondary School Science and Mathematics project (SESEMAT) in 2006 aimed at In-Service training for science and mathematics teachers.

SESEMAT officials go to schools and observe how science and mathematics are being taught. They also conduct qualitative and quantitative interviews with students and teachers. Based on their findings, they design and conduct in-service training for the teachers.

(i) Problems in science and Mathematics in secondary schools.

In a baseline survey conducted by Kyambogo University in 2004 and by SESEMAT in 2005, the following problems were identified.

- Poor performance in science and mathematics
- Most teachers use pre-dominantly teacher-centred methods of teaching. There is need to shift from teacher-centred to child-centred pedagogies.

- Learner's views and previous knowledge are not respected. Teachers act as fountains of knowledge and learners are taken to be passive absorbers of knowledge.
- Learners view science and mathematics as hard and boring.
- Learners can not relate science to their daily life experiences and applications.
- Many teachers work in isolation. Teachers rarely work in teams or share knowledge and experiences with each other. There was need for teachers to come together.
- Many teachers lack motivation.
- Some teachers have developed a negative attitude towards teaching as a result of seeing no gain after working for a long time.
- Most teachers go to class without lesson preparation.
- There is under-utilization of resources. Some teachers teach theoretically even when equipment and chemicals are available.
- A number of topics were identified by students are being hard, boring and abstract. Teachers also reported the same topics as the most difficult to teach practically. These included the mole concept in chemistry, electromagnetism in Physics and genetics in biology.

(ii) The ALEI/PIEI Pedagogical shift

Ssemondo informed participants that SESEMAT advocates for ALEI lessons through the PIEI approach.

ALEI is an acronym for **A**ctivity/experiment, **L**earner-centred, **E**ncouragement and **I**mprovisation.

PIEI is an acronym for **P**lanning, **I**mplementation, **E**valuation and **I**mprovement.

Elements of an ALEI lesson

- **Activity (Experiment)**

Teachers must include in the lesson hands-on and minds-on activities. These activities assist the learners to concretize concepts and arouse their curiosity in learning. The activities include:

- Experiments
- Demonstrations
- Discussions
- Modelling and exercises
- Presentations etc.

- **Learner-centred**

The teacher must assume the role of a facilitator in the teaching learning process by encouraging the learners to freely express their views, share experiences, derive hypothesis and explain their findings.

The learner is able to:

- Set up apparatus from instructions
- Perform experiments
- Record observations
- Manipulate data
- Interpret results and draw conclusions
- Verify predictions.

Prior knowledge/experience and experience gained from the activities in the lesson enable the learners to construct new knowledge.

- **Encouragement**

Learners' achievement is enhanced by an academic environment of encouragement provided by all stakeholders. Encouraging learners:

- Motivates them to learn how to learn and to take control of their learning.
- Helps learners develop a positive attitude towards science and mathematics.

- **Improvisation**

The teacher should plan appropriate experiments and activities that relate to the learners' experience. Planning for such activities calls for the teacher's innovativeness in:

- Making use of resources available in the learner's immediate environment and real life experiences.
- Designing appropriate experiences to enhance learner's participation and learning.

The PIEI Approach

Good **planning** of lessons followed by effective **implementation** will lead to effective delivery of lessons which can be ascertained through assessment and **evaluation**. The results of assessment and evaluation can be used by the teacher to **improve** the subsequent lessons leading to improved performance in science and mathematics.

In his concluding remarks, Ssemondo outlined a number of factors that improve learners' performance in Science and Mathematics. These include:

- Attitude and expectation of parents and teachers.
- Instructional strategies e.g. hands-on and minds-on experiences, group projects, field trips and interactions with role models.
- Involvement in out-of-class activities.

- Conferencing between teacher and the learner.
- Tracking learners' ability- group class assignments.

In addition, the teacher should:

- Develop learners' problem- solving skills.
- Foster cooperative learning.
- Show enthusiasm and have a high expectation for all.
- Use activities and resources that are familiar within the cultures of a wide variety of learners.

Thursday 1st Feb 2007

Activities of the day

Time	Activity	Lead by Whom
8:30 -10:30 AM	-Discussion of video as a teaching tool - Viewing educational video clips produced by teachers in previous workshops	- Kakinda Daniel - Participants
10:30 -11:00 AM	BREAK	
11:00 -12:30 PM	-Viewing educational video clips produced by teachers in previous workshops - Post viewing discussions	- Facilitators lead by Kakinda Daniel -Participants
12:30 -1:30 PM	- Presentation on storyboarding	- Nalubega Diana
1.30 -2:00 PM	LUNCH	
2:00 – 3:40 PM	Participants form four groups (Biology, Physics, Chemistry and Mathematics) and develop storyboards.	- Facilitators - Participants
3:40 -4:00 PM	BREAK	
3:00 – 4:00 PM	Development of storyboards	- Participants - Facilitators

Discussion of Video as a teaching tool

In a brainstorming session, lead by Kakinda Daniel, participants were asked to identify the advantages and limitation of educational videos as a teaching tool.

(a) Advantages of video as a tool for teaching.

Participants mentioned the following as some of the advantages of using video as a tool for teaching.

- Expertise can be retained even when the expert (good teacher or resource person) has left school or is absent.
- Can be used to bring the environment into the classroom.
- More cost effective and time saving.
- Re-usable and can easily be replicated cheaply.
- Video is an audio-visual aid. Stimulates many senses including sound and vision.
- Can be used even by non-subject experts.
- Interesting and motivating to the learners.
- Virtual tours to cut down on the expenses.
- Allows for time compression.

(b) Limitations of Video as a Teaching tool

Participants mentioned the following as limitations of video as a teaching tool.

- Not interactive. The teacher must be there to answer questions from the learners.
- Provides minds-on but not hands-on activities.

Analysis of educational video clips produced by other teachers in previous workshops.

Participants had the opportunity of viewing un-edited video clips which had been produced by other teachers in previous workshops.

The main objectives of using video clips produced by other teachers as case study were:

- To show the participants a range of possibilities.
- Use concrete examples as a basis for discussion of what is involved in the production of good educational videos.

Video clips used included:

1. Adaptation in plants.
2. Extraction of insecticide from lemon peeling.
3. The Physics of musical instruments.
4. The fish aquarium.
5. Acid-Base Titration demonstration.
6. Connecting a computer system.
7. Laboratory preparation of oxygen from hydrogen peroxide.
8. Succession in plants.
9. Pressure in liquids and in the atmosphere.
10. Strength of materials (struts & ties).

Post-viewing Discussion questions

The participants were asked to look for answers to the following questions as they viewed the video clips.

- Who are the different people behind a video production and what are their responsibilities?
- What things should be considered or emphasized in the production of a good educational video?
- What things should be avoided when producing an educational video?

Post-viewing Discussions

a) People behind the video production

Participants identified the following people to be behind a good video production

- Camera person
- Presenter(s) or Narrator(s)
- Director
- Helping hands

b) Things to be considered for a good video production

- Adequate preparation.
- Allocation of responsibilities.
- Story boarding.
- Proper choice of site location.
- Time allocation.
- Audibility of presenter(s).
- Pre-testing before shooting.
- Video shooting.
- Video editing

c) Things to avoid

- Filming without a story board.
- Unnecessary noise /disruptions.

d) Responsibilities of the people behind the video

- **Presenter/ Narrator**
 - Be audible.
 - Look into the eyes of the audience (in the camera).
 - Write down and practice what to say.
 - Speed of talking should be audience friendly.
 - Body and facial expressions.

- Should avoid mannerism.
 - Needs to be a subject expert.
 - Allow enough time for the camera person's movements.
- **Camera Person**
 - Need not be a subject expert.
 - Needs to follow the story board so as to capture areas of emphasis.
 - Should have the highest sense of silence.
 - Should decide when to pause the filming but needs to communicate this to the narrator using signs.
 - Should hold the camera steadily when recording. Preferably, a stand can be used.
- **Director**
 - Prompts the narrator to follow the storyboard.
 - Prompts the camera person to follow the storyboard.
 - Should stand near the camera person and prompts the camera person to pause the recording in case of any external interruptions or deviations from the storyboard.
 - Plans how to communicate with the narrator and camera person without causing interference in the recording.
 - Should not appear in the recording.

Presentation on producing educational video clips.

A presentation of “**Producing Educational video Clips**” was facilitated by one of the participants, Nalubega Diana, a female biology and computer teacher at Dubani Girls School.



Fig 9: Presentation on Producing Education Video Clips by Diana Nalubega

(i) Why produce an educational video clip?

Some of the reasons for producing an educational video clip may include:

- The learning resource may not be available to everyone at anytime.
- The learning resource may be too far away that it would be expensive or impossible for some learners to access.
- The learning resource may be a good presentation made by a person who is not always available.

(ii) Steps to follow in producing an educational video.

- Identify a need
- Establish the materials/equipment you are to use.
- Identify the scene(s) where do the filming from.
- Identify the people you are to involve.
- Make a storyboard.

(iii) Why a storyboard?

In producing an educational video, everybody needs to know what to do when and where because there are several people involved in the production of the video. The storyboard outlines in great detail **who** is to do **what**, **where**, **when** and for **how long**. A storyboard is a document with every detail of all what is to take place in a video clip.

(iv) What should be in the storyboard?

The storyboard should have every detail including:

- The theme of the educational video.
- The aim of the video clip.
- The objectives of the video clip.
- The target audience.
- The scene(s) of the video clip
- Who will do what, when and how.
- The timing for each activity.

The participants were also given some guidelines.

- The narration must be written down and rehearsed. This helps to check whether the narration fits in the time allocated and whether the narration communicates the intended message to the target audience.
- The narrator must not be camera-shy and needs to look into the camera because this is where the audience to be is at the time of filming.
- Final product will greatly depend on the camera person who needs to follow the storyboard and avoid capturing unwanted objects and actions.

Developing the storyboards.

Participants divided themselves in four teams according to their subject specialization (Mathematics, Biology, Chemistry and Biology).

Group	Group Members
Biology	Apora Patrick, Nalubega Diana, Etyang Olukan
Chemistry	Nasirumbi Olive, Oguban Robert, Were Victor, Masakala Milton
Mathematics	Mbuga Abdullah, Kombe Karisa
Physics	Muruya Barasa Stephen, Wamema Robert, Wafula S Mark, Nabasiye Susan

Each group was charged with the task of:

- Identifying the theme
- Identifying the target audience
- Identifying the objectives of the video clip.
- Divide up the roles (Narrator, Camera Person, Director)
- Identifying the scenes and the activities at each scene.
- Allocate time to each activity bearing in mind that each video clip must not exceed 20 mins.

Each group was encouraged to keep discussing their ideas with the facilitators who were to be moving around from group to group.



Figure 10: Chemistry group discussing their storyboard

Participants came up with four storyboards.

Group	Theme	Objectives
Biology (S.3)	Mammalian Vertebral Column	Learners should be able to: <ul style="list-style-type: none"> • State the functions of the skeletal system that are performed by the vertebral column. • Identify vertebrae belonging to the different regions of the vertebral column. • Explain the varied structural modifications of these bones.
Chemistry (S.3)	Electrolysis of acidified water (dil. Sulphuric acid)	Learners should be able to: <ul style="list-style-type: none"> • Describe electrolysis of acidified water (dilute sulphuric acid). • Connect up apparatus for the electrolysis, improvising where necessary. • Compare volumes of the gases produced in relation to the chemical reactions involved.
Mathematics (S.3)	Making and using a clinometer to measure angles of elevations and depression and height of tall objects	Learners should be able to: <ul style="list-style-type: none"> • Make a clinometer. • Find the angles of elevation. • Find the height of tall objects.
Physics (S.3)	Functions of a Cathode Ray Oscilloscope.	

Friday 2nd Feb 2007

Activities of the Day

Time	Activity	Lead by Whom
8:30 -10:30 AM	Analysis of participant's education video storyboards.	Lawrence Ssenkubuge
10:30 -11:00 AM	BREAK	
10:30 -1:30 PM	Setting, pre-testing & recording of video clips.	Participants
1.30 -2:00 PM	LUNCH	
2:00 – 3:00 PM	Personal testimonies of how ICT has changed personal lives.	-Lawrence Ssenkubuge - Daniel Kakinda
3:00 – 4:00 PM	-Reflections on the workshop - Closing Remarks - Award of certificates	- Participants - Facilitators & host school

Analysis of the education video storyboards

Participants' storyboards were analysed in terms of clarity of the theme, clear identification of the target audience, division of roles and collaboration among the team members, camera dynamics and detail of is to be said and timing of activities.

Participants were given the opportunity to comment and make suggestions for improvement to their colleagues.



Fig 11: Chemistry group preparing equipment and chemicals.

Participants then proceeded with the filming of their education video clips.



Fig. 12: Biology group shooting their video clip.

The participants produced the following video clips:

- Mammalian vertebral column (Biology)
- Electrolysis of acidified water (dil. sulphuric acid)(Chemistry)
- Making and using a clinometer to measure angles of elevations and depression and heights of tall objects.(Mathematics)
- Functions of a Cathode Ray Oscilloscope.(Physics)

Closing of the Workshop

Two of the workshop facilitators; Kakinda Daniel and Ssenkubuge Lawrence gave their personal testimonies of how they joined the band wagon of ICT in Education, the challenges they encountered, the successes they have achieved and how ICT has impacted their lives.

The testimonies were then followed by Award of Certificates of completion to the workshop participants and facilitators.



Fig 13: Nasirumbi Olive, a female Biology and chemistry teacher of Busia SS receiving a certificate of completion.

The certificates bore the logos of SchoolNet Uganda, Ministry of education and Sports, Digital Links and Barclays Bank



Workshop Evaluation:

Participants were each given a piece of paper and asked to write down some of the things they had learned or gained from the workshop as part of the workshop evaluation.

Below are some of the things participants wrote they had learnt /gained from the workshop.

- Working as a team to achieve common objectives.
- That ICT is a global reality and everybody must be ICT literate.
- Science and Mathematics projects on ICT and how to improvise in situations where apparatus, materials or equipment are not enough.
- That learning does not stop and I am now a child starting to learn ICT.
- Learnt to teach science scientifically using ICT.
- Have been exposed to better method of teaching sciences.
- Have been made to realise that there is an opportunity to develop my knowledge once I get determined.
- Have learned that one can rise up from a humble beginning to become a great resourceful person.
- I have been able to overcome my critical fear of operating a computer.
- I have learnt how to use a computer to teach science in a virtual lab at school.
- To be a serious ICT enthusiast, you must have self esteem.

- Bringing the external environment into the classroom situation.
- Application of computers in the teaching of science.
- How to prepare a video clip and how to use in teaching.
- Free interaction and making new friends.
- Technology is advancing very fast to the level that one can create Virtual Reality models (3D real-time computer simulations).
- Through ICT one can succeed in life and get international exposure.
- That ICT can be used to teach science subjects and make them more understood.
- Through ICT you can learn more about the world and interact with more people.
- How to use a computer and video clips as teaching and learning tools.
- Sharing ideas is extremely important since different people have different ideas.
- One can get affordable computers from SchoolNet Uganda.
- The personal testimonies and the video clips have been so inspiring to me.
- I have managed to polish my presentation skills because I was given a chance to facilitate one of the sessions.
- I have meet other teachers whom I can interact and exchange information after the workshop.
- Learnt a very simplified but effective way of teaching sciences using ICT.
- ICT can be integrated in Education and can effectively enhance the teaching and learning activities.
- Using virtual labs for science teaching and making educational video clips.

One of the participants had this to say:

“I have dropped the idea of resigning due of the heavy work of traditional teaching methods. This is because ICT makes teaching not only easier but also enjoyable”

..... Apora Patrick (Biology teacher, Masaba College, Busia)

Appendix 1: List of Participants.

NO	NAME	SCHOOL	SUBJECT	CONTACTS
1	Nalubega Diana	Dabani Girls School	Biology, Sports and Computer	0774214215 dianekanyunyuzi@yahoo.com
2	Jerome Egesa	Masaba College Busia	Economics & History	
3	Nannozi Joyce	Makerere College School	PCBM	
4	Oguban Robert	Masaba College Busia	Biology & Chemistry	0772595311
5	Nasirumbi Olive	Busia S.S	Biology & Chemistry	0772398026
6	Ssenkubuge Lawrence	St. Henry Kitovu	Phy, Maths, ICT	
7	Nakalembe Solome	Dabani Girls School	Biology & Chemistry	0782532269 somarie08@yahoo.com
8	Kizza Vincent	Makerere College School	Phy, Maths, Computer	0712312130 vkizza2001@yahoo.com
9	Mbuga Abdullah	Busia S.S	Maths and Computer	0772348013
10	Nabasirye Susan	Dabani Girls School	Phy, Maths	0782905890
11	Were Victor	Masaba College Busia	Biology & Chemistry	0772982869
12	Wamema Robert	Dabani Girls School	Phy, Maths	0774428151
13	Sr. Stella Tino	Dabani Girls School	Lit and English	
14	Apora Patrick	Masaba College School	Biology	0782523797
15	Ssenkunja John	3Rs Sec School	Biology	0752631130 ssenkunja@gmail.com
14	Ntabaazi Geoffrey	SchoolNet Uganda	History, CRE	0782022196 gntabaazi@yahoo.com
15	Kakinda Daniel	SchoolNet Uganda	Physics	dkakinda@yahoo.com 0772820167

16	Balasa. Stephen. M.	Dabani Girls School	Phy, Maths	0782168316
17	Wafula. S. Mark	Luma Eastern College	Phy, Maths	0721583948
18	Kombe. L. Karisa	Luma Eastern College	Phy, Maths	0736486437
19	Etyang Olukani	Luma Eastern College	Biology	0752389578
20	Masakala Milton	Dabani Girls. S.S	Chem, Maths	0782425105

Appendix 2: Physics Practical

Physics Practical work: (Using a simulation to determine focal length of a lens

Instead of the normal glass lens, students are required to use the **Geometric Optics** at the **Physics Educational Technology website**.
[\(<http://www.colorado.edu/physics/phet/web-pages/index.html>\)](http://www.colorado.edu/physics/phet/web-pages/index.html)

Note, the simulations at this website could be downloaded in advance so that the students can work offline.

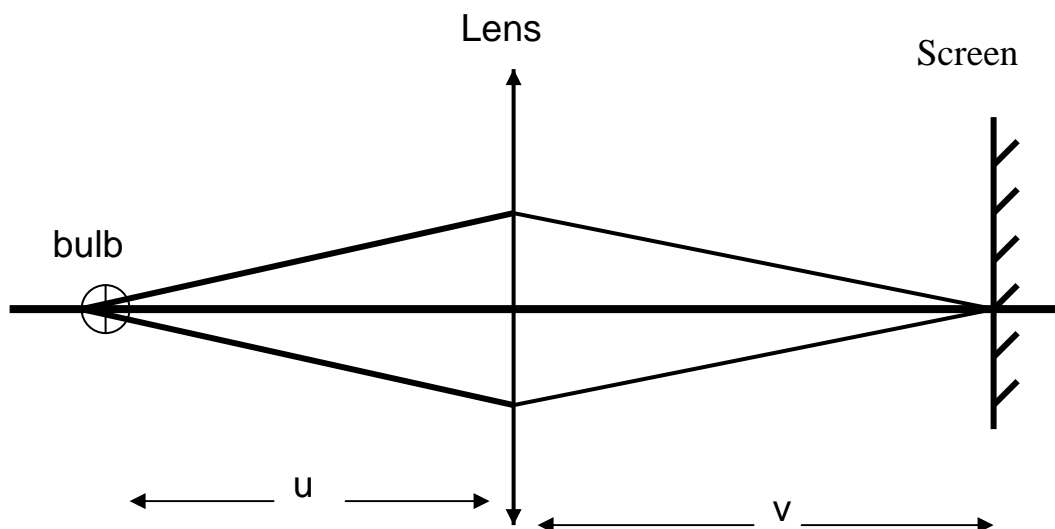
Students must be provided with a pencil, ruler and a graph paper. It must be emphasized that use of this simulation does not replace all what is involved in the traditional experiment. It is only the physical equipment which has been replaced by the electronic equipment. The students have still to draw the table of results, take measurements, plot them on the graph, draw the best possible line through the points, and determine the slope of the graph like in the traditional experiments. In this case ICT would just be addressing the problem of shortage of experiment.

Expt 1: DETERMINATION OF THE FOCAL LENGTH, f , OF A CONVERGING LENS USING THE GEOMETRICAL OPTICAL SIMULATIONS

- (a) Select a converging lens of refractive index $n = 1.53$ and radii of curvature $r = 0.63$ m and diameter $= 0.8$ m. Do this by adjusting the radius of curvature to 0.63m and the refractive index to 1.53. Also and choose marginal rays, screen and ruler.
- (b) Calculate the focal length f_1 of the lens using

$$\frac{1}{f_1} = (n-1) \left(\frac{1}{r} + \frac{1}{r} \right)$$

- (c) Arrange the screen the lens and the illuminated object as shown in the fig. below.



- (d) Place the object (bulb) at a distance $u = 100$ cm from the lens and adjust the position of the screen until a clearly focused image is obtained. Measure and record the image distance v . Calculate the linear magnification $m = \frac{v}{u}$.
- (e) Repeat (d) above for object distances $u = 120$ cm, 140 cm and 180 cm.
- (f) Tabulate your results including columns for u , v , m .
- (g) Plot a graph of m against v and determine the slope, s , of the graph.
- (h) Calculate the focal length f_2 of the lens using $f_2 = 1/s$
- (i) Calculate the average focal length f of f_1 and f_2 .

Appendix 3:

Chemistry and ICT Task 2

Objectives:

By the end of this exercise you will be able to:

1. Have discovered some of the Chemistry experiments that you can do or support using the virtual Lab.
2. Specifically perform a titration(Strong acid and strong base) experiment using the virtual Lab
3. Reflect/ Project on those areas of chemistry which you can improve or support using the virtual Lab.
4. Meditate and plan how to lure your fellow teachers into the use of virtual chemistry to improve science teaching.

Tasks

In this exercise we shall determine the Volume of 10 M HCl needed to neutralize 100 ml of **1.0 M NaOH**.

Method 1:

Calculation

1. Calculate the number of moles of **NaOH** in 100 ml of 1.0 M solution
2. Write an equation for the reaction between **NaOH** and **HCl**.
3. Determine the number of moles **HCl**. Needed to completely neutralize the moles of **NaOH** in the 100 ml.
4. Hence find the volume of a 10 M **HCl** that contains these moles

Method 2

Virtual Titration.

Carry out the following steps.

1. Open the virtual Lab.
2. Place a 250 ml flask on the bench
3. Place a flask containing the 10 molar HCL and one containing the 1M NaOH on the bench.
4. Draw 100 ml of **1.0 NaOH** from the container flask and pour it into the 250 ml flask on the bench.
5. Place a 50 ml burette on the work bench
6. Collect /draw 40 ml of Acid from the acid flask. and put it into the burette
7. Record the initial level of the acid in the burette.
8. Place some Phenolphthalein indicator reagent bottle on the bench
Be careful on the way you get the indicator from the indicator bottle and use very small quantity e.g. 0.1 ml
9. use a disposable pipette to put 0.2 ml of indicator into the flask containing sodium Hydroxide(Take note of the colour and the reading of the PH meter)
10. In the reaction you will need to add acid successively until the ph reduces to 7 i.e. the colour will become colorless.
11. By successively allowing 0.3ml of acid to pour into the flask containing the base and titrate until the colour changes.
12. record the new level of the acid in the burette
13. Calculate and record the volume of the acid used.
14. check your result by carrying out another titration using steps 2-12

Reflection:

How could this process be used in the teaching of chemistry?

Suggest how it could help you teach chemistry better.

Think and write a summary of the steps you could follow to carry out an experiment when teaching a certain concept in chemistry using virtual chemistry.

Appendix 4: Biology Practical**The e-Skeleton Practical**

You will use the e-skeleton project (<http://www.eskeleton.org/>) to explore the different aspects of primate skeletons.

By the end of the practical, learners will:

- Have toured the e-Skeleton project
- Be familiar with the variety of primate skeletons
- Be able to identify similarities and differences between different taxa.
- To used advanced techniques in understanding details of bone and teeth forms and structures.

Exercise: Comparative taxonomy of primates using brain size.

In the e-skeletons project (www.eskeleton.org), select the human taxon

- i. Chose the skull
- ii. Select the male cranium bone
- iii. Choose the lateral view
- iv. Select the measurement tool
- v. Measure the width of the skull in the region of the brain (just above the eye orbits)
- vi. Carry out similar measurements for the Gorilla, Baboon and Chimpanzee. Enter the values obtained in a table.

TAXON	CRANIAL WIDTH
Human	
Gorilla	
Baboon	
Chimpanzee	

- vii. Use the values obtained to draw a Bar graph.
- viii. From the graph, what taxon has got a brain size closest to the human?

- ix. What evolutionary trends can be traced in comparing the brain size in the various primates?
- x. How does this evidence compare with other evidences of the organic evolution theory?