

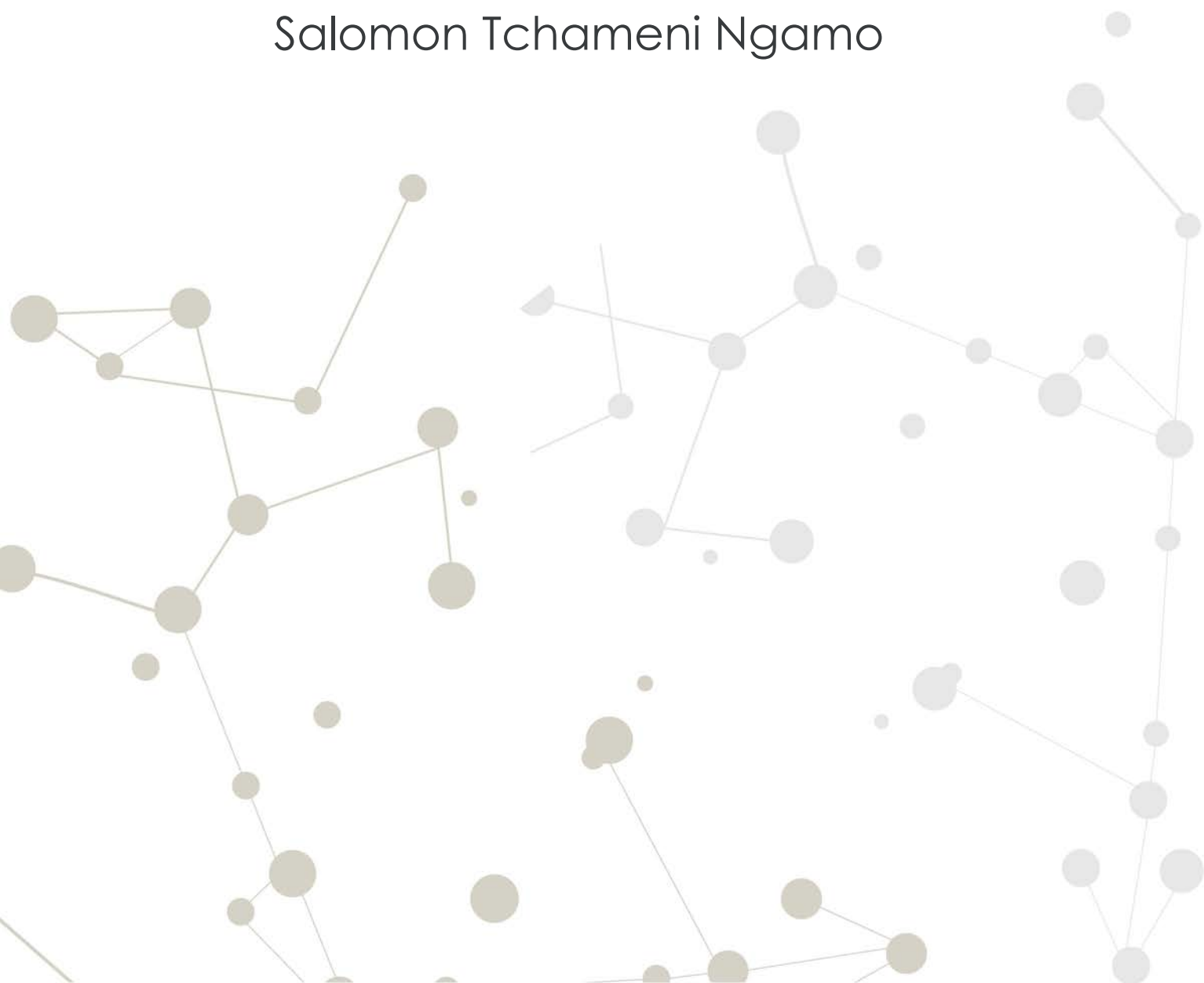


African Virtual University

Education: Education EDU21

# ICT INTEGRATION IN CHEMISTRY

Salomon Tchameni Ngamo



# Foreword

The African Virtual University (AVU) is proud to participate in increasing access to education in African countries through the production of quality learning materials. We are also proud to contribute to global knowledge as our Open Educational Resources (OERs) are mostly accessed from outside the African continent. This module was prepared in collaboration with twenty one (21) African partner institutions which participated in the AVU Multinational Project I and II.

From 2005 to 2011, an ICT-integrated Teacher Education Program, funded by the African Development Bank, was developed and offered by 12 universities drawn from 10 countries which worked collaboratively to design, develop, and deliver their own Open Distance and e-Learning (ODEL) programs for teachers in Biology, Chemistry, Physics, Math, ICTs for teachers, and Teacher Education Professional Development. Four Bachelors of Education in mathematics and sciences were developed and peer-reviewed by African Subject Matter Experts (SMEs) from the participating institutions. A total of 73 modules were developed and translated to ensure availability in English, French and Portuguese making it a total of 219 modules. These modules have also been made available as Open Educational Resources (OER) on [oer.avu.org](http://oer.avu.org), and have since then been accessed over 2 million times.

In 2012 a second phase of this project was launched to build on the existing teacher education modules, learning from the lessons of the existing teacher education program, reviewing the existing modules and creating new ones. This exercise was completed in 2017.

On behalf of the African Virtual University and our patron, our partner institutions, the African Development Bank, I invite you to use this module in your institution, for your own education, to share it as widely as possible, and to participate actively in the AVU communities of practice of your interest. We are committed to be on the frontline of developing and sharing open educational resources.

The African Virtual University (AVU) is a Pan African Intergovernmental Organization established by charter with the mandate of significantly increasing access to quality higher education and training through the innovative use of information communication technologies. A Charter, establishing the AVU as an Intergovernmental Organization, has been signed so far by nineteen (19) African Governments - Kenya, Senegal, Mauritania, Mali, Cote d'Ivoire, Tanzania, Mozambique, Democratic Republic of Congo, Benin, Ghana, Republic of Guinea, Burkina Faso, Niger, South Sudan, Sudan, The Gambia, Guinea-Bissau, Ethiopia and Cape Verde.

The following institutions participated in the teacher education program of the Multinational Project I: University of Nairobi – Kenya, Kyambogo University – Uganda, Open University of Tanzania, University of Zambia, University of Zimbabwe – Zimbabwe, Jimma University – Ethiopia, Amoud University - Somalia; Université Cheikh Anta Diop (UCAD)-Senegal, Université d' Antananarivo – Madagascar, Universidade Pedagogica – Mozambique, East African University - Somalia, and University of Hargeisa - Somalia

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The following institutions participated in the teacher education program of the Multinational Project II: University of Juba (UOJ) - South Sudan, University of The Gambia (UTG), University of Port Harcourt (UNIPORT) – Nigeria, Open University of Sudan (OUS) – Sudan, University of Education Winneba (UEW) – Ghana, University of Cape Verde (UniCV) – Cape Verde, Institut des Sciences (IDS) – Burkina Faso, Ecole Normale Supérieure (ENSUP) - Mali, Université Abdou Moumouni (UAM) - Niger, Institut Supérieur Pédagogique de la Gombe (ISPG) – Democratic Republic of Congo and Escola Normal Superior Tchicote – Guinea Bissau

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# Production Credits

This second edition is the result of the revision of the first edition of this module. The informations provided below, at the exception of the name of the author of the first edition, refer to the second edition.

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AVU Multinational Project II funded by the African Development Bank.

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# I. INTRODUCTION

## 1.1 Title of Module

ICT INTEGRATION IN CHEMISTRY

## 1.2 Prerequisite

ICT basic Skills

Access to a computer

Access to Internet\* (highly recommended for many activities)

## 1.3 Time

120 h (40hrs. focusing on general teaching skills in the use of ICTs in education; 80 hrs specific to the use of ICT in Chemistry)

## 1.4 Material

Computer software and data logging equipment in chemistry.

Portable ICT devices for modelling and simulation.

Worksheet, spreadsheet, database templates and graph drawing software.

Web-based resources: for interacting with appropriate teaching and learning chemistry materials on CD-ROMs, websites and interactive multimedia display boards.

Word-processing facilities.

## 1.5 Module Rationale

Information and communication technologies (ICT) have become one of the fundamental building blocks of modern society. Many countries now regard the mastering of the basic skills and concepts of ICT as an inevitable part of the core of education. To this end, various new models of education are evolving in response to the new opportunities that are becoming available by integrating ICT and in particular Web-based technologies, into the teaching and learning environment. The effective integration of such applications however, depends to a large extent on teacher's familiarity and ability with the IT learning environment. Science teachers need to know exactly how ICT is used as a teaching and learning tool, for their own purposes and to help students to use them. This module is about the integration of ICT as a tool in the chemistry/science classroom with the overall aim of increasing the effectiveness of teaching and improving students' learning. The module outlines a programme of objectives and related activities for an ICT-enhanced learning environment in chemistry teaching and learning.

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# II. CONTENT

## 2.1 Overview

The process of integrating ICT in education is not always a simple and straightforward one. The transition from traditional teaching to ICT-enhanced environment is not always obvious. Overlaps in the application of ICT tools in teaching often occur. For instance, ICT tools are sometimes used in combination with non-ICT strategies such as shifts from textbooks based to web-based books or from power point presentation in class to power-point presentation via the Internet. Sometimes they both operate in parallel, in conjunction or interchangeably.

This module presents identified themes together with exemplar activities to assist teachers in better integrating ICT in their teaching of chemistry., students. First an introduction to the theories and principles of ICT integration is presented within the identified themes. These principles are further developed into seven specific learning objectives of ICT application in the context of chemistry teaching.

## 2.2 Outline

The content of this module focuses on developing those teacher competencies and abilities common to all approaches to integrating ICT in learning, as teachers seek ways to improve their teaching. Examples of these general competencies include among others, ability to decide why, when, where, and how ICT tools will contribute to teaching objectives; how to choose from among a range of ICT tools those that are most appropriate to stimulate learning and improve the quality of education offered; ability to facilitate students' use and analysis of information from the Internet and ICT-based sources in relation to learning in specific subject areas or topics in chemistry. In summary, the process of integrating ICT in chemistry say, is of necessincremental and requires that you as the teacher have clearly defined objectives for its effectiveness in education.

The integrated use of ICT in subject curricula and classroom teaching and management is a complex process, which is usually achieved by following a set of guiding parameters. In this module, there are two complementary activities: the first focuses on the theories and principles that underpin ICT integration in education; and the second is teachers' computer-assisted practice in the use of ICT with support web-based portals.

The two main trends in content focus are as follows:

- Pedagogical principles and theories of ICT integration in Education:
- ICT in Education Projects and Themes (20hrs)
- ICT for Chemistry Teaching and Teacher Professional Development: Chemistry specific learning activities The module content provides a teacher training curricula that incorporates the pedagogy, i.e. specific learning objectives and learning activities required to effectively integrate ICT into Chemistry education.

## 2.3 Conceptual framework

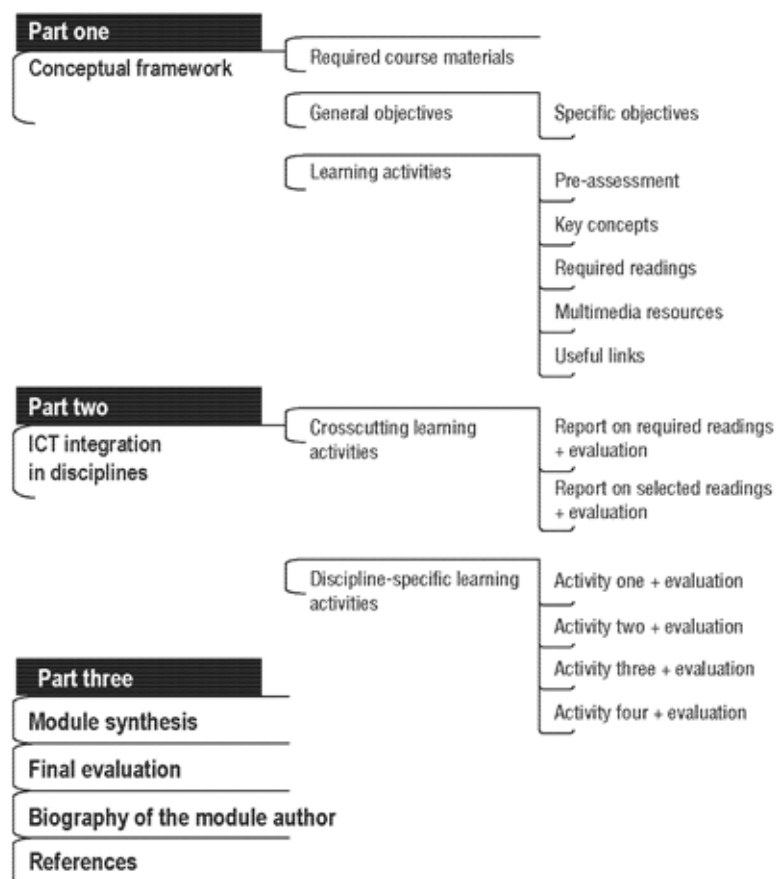
- 2.3.1 Required course materials
- 2.3.2 Module Rationale
- 2.3.3 General objectives, Specific objectives
- 2.3.4 Learning activities
- 2.3.5 Pre-assessment
- 2.3.6 Key concepts
- 2.3.7 Required readings
- 2.3.8 Multimedia resources
- 2.3.9 Useful links

## 2.4 ICT integration in specific disciplines

- 2.4.1 Crosscutting learning activities
- 2.4.2 Report on required readings + evaluation
- 2.4.3. Report on selected readings + evaluation
- 2.4.4. Discipline-specific learning activities
- 2.4.5. Activity one + evaluation
- 2.4.6. Activity two + evaluation
- 2.4.7. Activity three + evaluation
- 2.4.8. Module synthesis
- 2.4.9. Final evaluation
- 2.4.10. References

2.5 Graphic Organizer

**Pedagogical integration of ICT in  
Biology, Chemistry and Mathematics**



**2.6 General Objective(s)**

The module’s general objective is to help teachers and student-teachers of chemistry, to know how to use ICT as a tool for designing new learning environments for their own subject-specific purposes and to help their future students to use ICT. Exposure to this module is expected to provide the teacher and student-teacher with the knowledge, skills and attitudes to better use technology in their lesson-planning and lessons, research, communication, problem-solving, and continuing professional development

### **2.7 Specific Learning Objectives (Instructional Objectives)**

The principles of ICT integration in education are expressed here as seven specific learning objectives for Chemistry. Students should be able to:

- Critically apply the pedagogical principles of ICT integration in education.
- Develop ICT-based learning activities in the context of teaching chemistry.
- Evaluate appropriate content and context for the use of ICT in chemistry teaching.
- Use appropriate and varied communication and multimedia tools (emails, websites etc) in teaching and learning chemistry.
- Use ICT efficiently in research, problem solving and project-based learning in chemistry.
- Use ICT efficiently for professional development in the context of teaching and learning chemistry.
- Integrate ICT appropriately into chemistry curriculum activities that will foster students ownership of their ICT-rich learning environment.

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# III. TEACHING AND LEARNING ACTIVITIES

## 3. 1. Pre-assessment: are you ready for this module?

### Learners:

In this section, you will find self-evaluation questions that will help you test your preparedness and readiness to complete this module. You should assess your performance objectively after completion of the self-test, and carry out the recommended action based on your score. We encourage you to take your time in answering the questions.

### Instructors:

The Pre-assessment questions below are meant to guide the students to help them decide whether they have sufficient background knowledge and skills required for the completion of the content presented in this module. As the instructor you should encourage your learners to evaluate themselves by attempting all the questions provided below. It is advised that the individual student abides by the recommendations made on the basis of the mark obtained. Education research consistently shows that compliance with the recommendation, will ultimately help learners to be better prepared for linking the new with their existing knowledge.

## 3. 2 Self -evaluation of ICT competencies

Evaluate your ICT competencies for this subject specific ICT integration exercise. If your score is equal to or greater than 60 out of 75, you are ready to use this module. If your score is between 40 and 60 you may need to revise your previous ICT basic skills course. A score less than 40 out of 75 indicates you need to do a basic ICT skills course.

Try the following questions and evaluate where you are in the ICT user spectrum.

## ICT Integration in Chemistry

| ICT INTEGRATION IN CHEMISTRY        |   | Level of confidence |      |      |      |           |
|-------------------------------------|---|---------------------|------|------|------|-----------|
| Areas of Competence                 |   | Low                 | Need | Good | High | Very High |
|                                     |   |                     | Help |      |      |           |
|                                     |   | 1                   | 2    | 3    | 4    | 5         |
| A) General                          |   |                     |      |      |      |           |
| 1                                   | Familiar with the AVU Basic ICT Skills (using word processors, spreadsheet software, web navigator, etc. See list of pre-requisites).                   |                     |      |      |      |           |
| 2                                   | Confident in guiding AVU's ODeL trainee. (lesson Planning, reference links, etc.)   |                     |      |      |      |           |
| 3                                   | Using a software (interactive whiteboard software to create and save flip charts. (Annotation desktop mode, flip chart, paste in objects, load images.) |                     |      |      |      |           |
| B.) Using ICT in Numeracy           |   |                     |      |      |      |           |
| 4                                   | Whole class teaching & group work Software e.g. Geogebra, Graph, ActivPrimary, Easiteach Maths, RM Maths, ICT in Maths, websites. Using RM Maths        |                     |      |      |      |           |
| Using ICT in Literacy               |   |                     |      |      |      |           |
| (Whole class teaching & group work) |   |                     |      |      |      |           |
| 5                                   | Software e.g. ActivPrimary Creating resources in generic software (e.g. TWAW, Talking First Word, My World3), websites.                                 |                     |      |      |      |           |
| C) Using ICT in Chemistry           |   |                     |      |      |      |           |



### III. TEACHING AND LEARNING ACTIVITIES

|  |   |  |  |  |  |  |
|--|---|--|--|--|--|--|
| 6                                      | Using virtual labs and simulations (e.g. Optics Bench Applet <a href="http://www.hazelwood.k12.mo.us/~grichert/optics/intro.html">http://www.hazelwood.k12.mo.us/~grichert/optics/intro.html</a> , Physics 2000), (e.g. Chemistry <a href="http://www.chm.davidson.edu/ChemistryApplets/index.html">http://www.chm.davidson.edu/ChemistryApplets/index.html</a> , |  |  |  |  |  |
|  | Using on line chemistry courses (e.g. Distance learning   |  |  |  |  |  |
|  | Technologies  |  |  |  |  |  |
| 7                                      | Using chemistry modelling software (e.g. Crocodile clips). See  |  |  |  |  |  |
|  | <a href="http://www.crocodile-clips.com/science/">http://www.crocodile-clips.com/science/</a>   |  |  |  |  |  |
| 8                                      | Use of other ICT resources (e.g. Junior Insight &   |  |  |  |  |  |
|  | Sensing/sensor equipment, digital camera, E-microscopes).   |  |  |  |  |  |
|  | Active Primary for whole class teaching   |  |  |  |  |  |
| D) Using ICT in Science                |   |  |  |  |  |  |
| 9                                      | Using generic software to present information and for creating pupil resources in (e.g. TAWW, Talking First Word, My World, data handling programs),  |  |  |  |  |  |
|  | Datalogging   |  |  |  |  |  |
|  | Research using websites & CD ROMS,  |  |  |  |  |  |
| E) Using ICT in other curriculum areas |   |  |  |  |  |  |

|    |  |  |  |  |  |  |
|----|--|--|--|--|--|--|
| 10 | Active Primary, creating resources in generic software (e.g. TAWW, Talking First Word, My World), websites, Micropedia CD ROM, other specific CD ROMs, digital camera, digital video camera. |  |  |  |  |  |
| 11 | Using the shared areas on the AVU and/or PI site (Read, Write & Homework) to put templates and files for the pupils, to share work.  |  |  |  |  |  |
| 12 | Using Office software (Word, Excel, Powerpoint) for professional use<br>e.g. to create and adapt teaching resources, write reports, plan out timetables, record pupil data.                  |  |  |  |  |  |
| 13 | Use the Internet for professional development (for accessing teaching resources, teaching information, copying images)   |  |  |  |  |  |
| 14 | Use software to record pupil's progress.   |  |  |  |  |  |
| 15 | Use of other ICT resources (e.g. scanner, digital camera)  |  |  |  |  |  |

### 3.3 Precautions about misconceptions in e teaching and learning

#### Learners:

This section offers support to students who may be worried about working with computers or using the Internet. You will find in this section a number of useful tips that would help you to avoid some of the more common pitfalls, misconceptions and prejudices..

Misconceptions about ICT sometimes arise as a result of misunderstandings or insufficient knowledge one has about how things work..

### III. TEACHING AND LEARNING ACTIVITIES

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For example, children may have a naïve view of how the computer works. They may ascribe to it super intelligence beyond the capabilities of any existing machine. Such a view may have arisen or been developed as a result of some of the more mind boggling things information technology has been able to achieve in modern times, in the world of work, social media and play. But having said that there is no doubt that access to ICT provides one of the best educational facilities necessary to prepare young people to play full roles in contemporary society and to contribute to a knowledge economy.

We need to make the point that not all teachers are convinced that ICT should be an integral part of their teaching strategies (Galanouli, Murphy, & Gardner, 2004). Some people have misgivings about any changes that impact on their comfort zone. So they tend to resist change. Resisting change is a state of mind for many teachers, and it is one of the most difficult barriers to effective ICT-subject matter integration.

To address some of the misgivings people may have, be prepared to discuss some of the concerns raised, if necessary engage in constructive debates that are meant to clarify issues and acknowledge limitations where they exist.

#### **3.4 Some Misconceptions in ICT use**

Here are some of the more common misconceptions:

- That a graphics file is different from a text file, or a word processor file.
- That a file currently being edited is merely a copy of the file in hard storage (and important too to note the exception for database files).
- That a data file for a picture is as different from a data file for text as a photograph is from a printed page. This is of course not true.
- That as one edits a document in a word processor the data file is automatically changed. But this is not true (until it is re-saved). The exception is a database in which any editing immediately changes the data file.
- That all web-pages are available indefinitely, without any time limit. This is not always the case. One needs to check the web site addresses before hand, to see whether they have limited life and when they are about to change.

#### **Precautions**

Students need guidance on the fine details of searching information from the Internet

As the instructor/teacher:

Avoid vague statements such as “search the Internet for particular types of activities. Most students need more direction than that. If you want students to do an Internet search, give them a preparatory activity where they consider appropriate key words to enter into a chosen search engine. It helps for the teacher to do a pre-lesson check to ensure that the selected key words produce the desired results.

Check the time it takes for the learning materials to be downloaded from your chosen sites before your lesson. If it takes an unusually long time then you have to plan your lesson accordingly.

Check the language used in your chosen web sites, to see if it is in accord with the language of instruction.

You may need to identify a short list of key words and concepts to be explained to students before they attempt any web site activities.

**Your first choice may not be available:**

- List some alternative web site addresses in case your first choices are unavailable.

### III. TEACHING AND LEARNING ACTIVITIES

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#### Undesirable links and updates:

- Search your selected web sites for links to undesirable web sites and advertising material. New links appear all the time. Check these just before the lesson.
- Search your selected web sites for features, which invite responses by email. See if a school email address can be submitted or if the option can be disabled. Avoid using web sites, which invite personal response by e-mail.

#### **Key words: Their usefulness and limitations:**

- Check for American spellings especially of key scientific words, e.g. Sulfur, instead of sulphur.

#### **Access to/from the school computer may be restricted:**

- Some school computers are programmed to block the saving and downloading of files, so the saving of files is limited.
- Some school computers block certain web sites, denying access.
- Check the computers, which you will use, for any special features before the lesson.

#### Backup an important aspect of ICT:

- Try to give out web site addresses in an electronic format, either saved to favourites, as an e-mail, on a floppy disk or on a CD ROM. Avoid writing long addresses on a board for typing into computers by hand. Typing wrong web site addresses can be very demoralizing to pupils.
- Keep a spare copy of your list of web site addresses on your own personal flash disc, floppy disk or CD ROM and keep this with you during the lesson.
- Once you have made your list of safe web sites, make it available to the pupils electronically, through a departmental web site, an electronic conference like First Class, or e-mail.
- Try to save your chosen sites to "Favourites" on the computers, which you will use. After you click the "Add Favourite" button, click to tick the box "Make available offline". Not all sites can be saved in this way. Those that can will be saved onto the machines, which you are using. This gives you the option to use the web site during the lesson without an active Internet link. Alternatively, you could burn CD ROM copies of the web sites, which you wish to use during the lesson, using a CD rewriter, and load the web sites before the lesson starts. The only disadvantage is that the CD ROM copies of the web site are not updated when the web site is updated.

### **Not all students have internet access at home:**

- You can tell pupils to use the Internet to support homework. However, you should provide computer access at school before the homework deadline for those who do not have access to a computer at home.
- If you present your small selection of web sites to the pupils as a CD ROM they do not have to go on-line and they can have a virtual Internet experience

### **Current and likely future developments in ICT.**

- Predictions about future development trends for ICT generally involve adjectives such as 'smaller, faster, and cheaper'. Increasing miniaturisation, portability and capacity of systems mean that the range of uses for ICT is increasing exponentially. The next major developments are likely to be:
- Wider adoption of technology such as USB, which will cut down the number of leads trailing from the back of computers as more devices will be 'piggy-backed' on to a single connection;
- 'Bluetooth' technologies, which make use of radio linking and will cut out the cables altogether. Faster access to the Internet with 'broadband' connections becoming widespread, which will lead to increased use of online multimedia resources such as audio and video. The implication for schools is that they must continue to play 'catch up', devoting significant resources to investment in technology and training.

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# IV. KEY CONCEPTS (GLOSSARY)

## Learners:

In this section, you will find key concepts useful in order to complete this module. You shouldn't consult them right away. Instead, we encourage you to briefly read over their descriptions and move on to the next section.

## Instructors :

The key concepts placed here introduce learners to the resources available to them in order to complete this module. As their instructor you should encourage learners to read the descriptions provided before moving on to the learning activities. Education research shows that this instructional and learning sequence helps learners to be better prepared to link previous knowledge to the new one.

1. **ICT** : Information (I) and Communication (C) Technologies (T) - the term ICT encompasses innovative audio visual, computing and telecommunications techniques which allow the acquisition, processing and storage of information. Many of these techniques come directly from computing and communications. A number of acronyms are used, including IT, NT and IS. The term ICT is becoming more and more common in science, in Open and Distance Learning, and in Pedagogical Integration of ICT.
2. **Pedagogical Integration of ICT**: This concept is not limited to the establishment of networks and/or the installation of equipment. It includes the use of technology in schools to improve learning and to facilitate educational development. .
3. **Software** : These are programs initially conceived to facilitate consumer use of ICT. There are various types of programs used in the Pedagogical Integration of ICT including learning, open source and "free" software. A number of support mechanisms exist to assist teachers and students in becoming comfortable and efficient with ICT. This support is often presented in the form of CD-ROMs, tutorials, exercises or other didactic material.
4. **Web Sites**: These are a collection of files (HTML pages, images, PDF, audio, video, Flash-animations) and folders forming the structure of a site, placed together in computer memory (on a work station during the development phase and a server when published), and linked together using hypertext. Access to a website can be global, using the World Wide Web, or limited to a local network. For any site to be accessible externally, web-server software must be operating on the server where the site is stored.
5. **E-Learning**: is a term used to refer to learning which takes place online.

Self-directed learning plays an important role in this type of education, demanding an increased level of learner autonomy. E-learning programs can be completed remotely using the Internet, or can include short sessions of face-to-face teaching.

6. **Synchronised communication:** Refers to a mode of real-time communication, using tools such as Instant Messaging, chat rooms, discussion forums, conferencing systems and bulletin boards.
7. **Non-synchronised communication:** E-learning offers the option to de-synchronise educator and learner time, allowing them to communicate based on their own schedules, in a non-synchronised manner, through multimedia information exchange networks – for example using email or e-platforms to submit work.
8. **e-portfolio :** Also called a digital portfolio, this tool is unique in that it can manage about a dozen file types (text, images, audio, video, presentations, hyperlinks). This new technology allows learners to subscribe to a portfolio, to organise their work, to be advised of updates, and to take tests and quizzes, in real-time. It is possible to communicate with the owner of a portfolio on [edu-portfolio.org](http://edu-portfolio.org), either by email, or via the “comments” function. Overall this tool is flexible, simple and easy to use, allowing information and evaluations to be organised and exchanged. Its potential applications offer very attractive prospects to E-learning programs.
9. **Internet :** Connection to a very large number of computers using communication networks, such as telephone lines, to exchange information worldwide. The Internet is, however, distinct from the World Wide Web (www), which, like email, is only one of the principle services available through the Internet.
10. **Intranet :** This concept generally designates regulated connection between a group of authorised users. A password can be required for members to access and exchange information on these smaller networks (which use similar technology to the internet). Web sites, or web pages, are examples of networks that use Intranet. In E-learning Intranet networks are an efficient way of exchanging information between learners, educators, and peers.
11. **Data logging:** This is simply the collection and storage of information. In chemistry, just as in other science subjects a main feature of practical activity has always been observation and measurement. The results obtained are then processed manually as data, and presented in graphs or tables. But modern technology is now able to perform this task. With the appropriate software, modern computer-assisted data logging is able to capture and instantly graph the data. This allows the students to focus on skills of data observation and manipulation that develop and enhance scientific thinking, creativity and problem solving ability.



### V. COMPULSORY READINGS

Learners :

In this section, you will find compulsory readings useful in order to complete this module. You shouldn't consult them right away. Instead, we encourage you to briefly read over their descriptions and move on to the next section.

Instructors :

The compulsory readings placed here introduce learners to the resources available to them in order to complete this module. As their instructor you should encourage learners to read the descriptions provided before moving on to the learning activities. Education research shows that this will help learners be more prepared and help them articulate previous knowledge.

#### **Abstract :**

This book has two objectives: the first to delineate an ICT educational program for secondary school teaching that responds to current international trends. The second objective is to outline a professional development program and to support teachers in its implementation. In addition, it lends a practical and realistic approach to educational programs and teacher training, which allows efficient implementation with a given set of resources.

#### **Rationale:**

This book is a UNESCO offering which aims to support educators and students in better integrating ICT, including multimedia, e learning and distance education, in the processes of training and knowledge sharing in the field of education. A particularly well-organized document, it offers examples of ICT applications in Mathematics, Biology, Physics and Chemistry teaching.

Compulsory Reading #2

Complete reference :

Becta (2005). The Becta Review 2005 : Evidence on the progress of ICT in Education. Becta ICT Research

#### **Abstract :**

This document is a scientific journal that surveys the impact of ICT in education. In particular, it notes the recent progress in classroom instruction. This journal also explores the inherent and current challenges of fully integrating ICT in education in a dynamic policy environment. In short, while demonstrating an increase in comfort with ICT amongst users, and that their use has increased significantly in the last two years, this document reveals that there is also real evidence of the positive impacts of ICT use in education.

#### **Rationale:**

This document is a valuable resource which allows a better comprehension of the importance of ICT as a set of educational support tools, especially in Open and distance learning. The evidence clearly presented in this text suggests directions for the development of new content for e-learning programs.

### Compulsory Reading #3

Complete reference :

UNESCO (2004). School networkings : Lessons learned. Bangkok : UNESCO Bangkok (ICT lessons learned series, Volume II).

#### **Abstract :**

This document is a collection of references for teaching with ICT. It presents a variety of methods to integrate ICT in teaching. The document, compiled by specialists, synthesizes a number of examples, and presents lessons learned on ICT use in schools in a variety of countries. These lessons could help improve the planning and integration of ICT in education. The text suggests tools to guide both policymakers and users in their advocacy, as well as to support ICT initiatives in education.

#### **Rationale:**

This document is a reference for ICT use in teaching and learning in specific discipline such as Biology, Chemistry and Physics. Like other texts in the series it helps to better understand the process of integrating ICT in teaching the disciplines and in the use of technology to enhance learning.

### Compulsory Reading # 4

Complete reference :

Becta (2002). ImpactCT2 : The Impact of Information and Communication Technologies. ICT in Schools Research and Evaluation Series - No. 7, Department for education and skills.

#### **Abstract :**

This text is the next in a series of research reports produced by the UK organisation BECTA, on the educational impact of ICT. It addresses issues related to the use of ICT in disciplines such as math and science. It presents, in four stages, the relative gains of regular and occasional users of ICT in each discipline.

Rationale:

It is important to read this document to better appreciate the benchmarks, and the real and potential impacts, for and of ICT use on learning in scientific disciplines. African teachers and learners faced with substantial challenges in their education systems can benefit from the experiences presented in this study to integrate ICT in their training practices.

### Compulsory Reading # 5

UNESCO (2002). Teacher Education Guidelines :Using open and distance learning. Education sector, Higher Education Division, Teacher Education Section in cooperation with E-9 Initiative.

## IV. KEY CONCEPTS (GLOSSARY)

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### **Abstract :**

This document addresses decision-makers, teachers and students who are faced with the daily challenge of broadening educational programs through Open and Distance learning. Among other objectives, this document attempts to bring to light responses to fundamental questions in open and distance learning for teachers – What does this training consist of, what is the curriculum and who are the educators, is this training appropriate? Who are the users, how should it be planned and organised, what technologies can be applied, how can it be financed, how can teachers develop competencies, how can they access these? These are the major questions broached in this important reference document for open and distance learning.

### **Rationale :**

This document addresses the inherent challenges of teaching in Open and distance learning. As a resource the text provides suggestions for financing, planning organising and activities, educational practices and evaluation. The document therefore presents useful information for collaborative work and further success in the field of Open and distance learning.

Compulsory Reading # 6

- Tchameni Ngamo Salomon (2006). Pedagogical Principles and theories of ICT integration in Education. AVU Teacher Education Authoring content Workshop. Nairobi - Kenya, 21st August to 2nd September.

### **Abstract :**

This text presents the fundamental ideas, which mark the way for ICT integration in education. The theories herein centre around six poles, which together provide the elements essential for consideration in the process of bringing ICT to learning the sciences.

### **Rationale :**

A clear objective is only as useful as a clear path towards it - this principal certainly finds application in education – for, while targets may be well defined, the path towards them must also be marked. It thus seems appropriate to gain familiarity with the issues facilitating the integration and application ICT, so as to prepare and pilot learning activities and to manage teaching.

Compulsory Reading #7

- UNESCO (2002). "Information and Communication Technology in Education: A Curriculum for Schools and Programme of Teacher Development (2002)".

### **Abstract:**

This manual provides a practical and realistic approach to teacher development in the context of integrating ICT into the curriculum at secondary school level. It outlines a teacher support programme for integrating ICT into the curriculum given a set of resources. The theoretical and practical underpinnings of such an approach to ICT integration are clearly explained examples and are adaptable to the different learning of science, and mathematics among others.

### Rationale

The chemistry student teacher or instructor can use the manual for developing subject-specific approaches to the use of ICT as a tool for designing new IT learning environments and helping their future students to use ICT. Many teachers are keen to develop professional expertise on ICT use in education. This book is designed to raise the knowledge for ICT applicability to subject-matter content in science, mathematics, languages to a minimum level, and to provide a foundation for further professional development.

Compulsory Reading # 8

- Barak, M; & Dori, Y.J. (2004). Enhancing Undergraduate Students' Chemistry Understanding through Project-based Learning (PBL) in an IT Environment. LEARNING
- G.J.Kelly and R.E Mayer Section Editors. Published online 19 November 2004 in Wiley Inter Science ([www.interscience.wiley.com](http://www.interscience.wiley.com))

### Abstract:

This research article is about the integration of project-based learning in an ICT environment. It describes and explains how this integrative approach contributes to enhancing student-directed chemistry problem solving ability in real-world setting. The study provides empirical support for the use of information technologies in project-based learning (PBL) in chemistry.

### Rationale

In investigating the integration of PBL in an IT environment in chemistry, the focus of the study was on the effect of IT-enhanced learning on students' achievement at various levels of understanding in chemistry. One of the contributions of this research to ICT-chemistry integration is in augmenting the growing body of knowledge on the use of computerized molecular modelling (CMM) and visualisation strategies in chemistry education. It is therefore useful and appropriate for you the student to be familiar with both the project design and implementation of such an approach to chemistry teaching and learning, that makes extensive use of CMM and the Web for visualisation and information inquiry.

Compulsory Reading # 9

- Barak, M (2005). Transition from traditional to ICT-enhanced learning environments in undergraduate chemistry courses. *Computers and Education*. Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

### Abstract

The article outlines the process of ICT integration in traditional chemistry teaching. Learning technologies were integrated into chemistry courses to enhance inquiry-based learning, visualisations, and knowledge sharing. For the chemistry teacher integrating new practices, i.e. the transition from traditional to ICT-enhanced learning environments is a phase-dependent process that consists of promises as well as complexities. Four transition steps were found to characterise the integration of ICT-learning environments.

### **Rationale**

The paper contains useful information on how to go about the integration of ICT in chemistry courses. Although ICT has been integrated in many chemistry courses and has shown educational benefits, changing teachers' traditional teaching is still a challenging process. The case study addresses teachers' positive and negative perceptions of ICT enhanced learning environment and then goes on to show how collaboration among faculty, is crucial for successful development and integration of ICT in chemistry education. This article is important for sensitising the student teacher to ICT-based curriculum issues, including barriers to ICT integration likely to influence chemistry teachers' readiness to learn and use new practices.

Compulsory Reading # 10

Kennedy, D. & Finn, Sean. (2000) The Use of Datalogging in Teaching Physics and Chemistry in Second-level Schools in Ireland. A Report submitted to the National Centre for Technology in Education and The Department of Education and Science. Ireland

### **Abstract**

The Report outlines a collaborative research project involving the Department of Education and the Irish Science Teachers' Association on the use of datalogging in school chemistry and physics. The project addresses in a comprehensive and inclusive manner two questions: first, how effective is datalogging in teaching chemistry and physics; secondly, what is the most suitable datalogging system for Irish secondary schools. Twelve pilot schools were investigated, six for chemistry and six for physics.

### **Rationale**

You will find the report a very useful source of information and ideas, with regard to the theory and practice of computer-assisted datalogging to enhance practical work in chemistry and physics. The report also addresses other valuable teacher professional development issues in the use of computer technology in teaching chemistry in the classroom or laboratory.

Compulsory Reading # 11

- UNESCO Bangkok (2003) Teacher Training on ICT Use in Education in Asia and the Pacific: Overview from selected countries. By Information Programmes and Services. Bangkok: UNESCO Bangkok, 52pp.

### **Abstract**

This 52-page Report is a synthesis of contents/topics of curricula for training teachers and others on ICT use in education from the selected Asia and Pacific countries. It provides summaries of the training contents in technology-pedagogy integration in the different disciplines of various organisations. This is an ongoing project which will see a continuous expansion and updating of the database as countries of the region begin to perceive the importance of contributing to its updating.

### Rationale

This highly informative inventory of professional development and teacher training programmes on ICT integration focuses on, ICT-related curriculum course contents, objectives, modules and training, materials developed, and methodologies. Data and information culled and analytically synthesised will assist you the chemistry student teacher in identifying and accessing the wealth of training resources that are already available and ready to use. For the instructor, the available information will assist in selecting and trying out/adapting existing training curriculum and existing materials rather than trying to reinvent the wheel.

## VI. MULTIMEDIA RESOURCES

### Learners :

In this section, you will find multimedia resources that are useful to complete this module. You should not consult them right away. Instead, we encourage you to briefly read over their descriptions and move on to the next section.

### Instructors :

The multimedia resources placed here introduce learners to the resources available to them in order to complete this module. As their instructor you should encourage learners to read the descriptions provided before moving on to the learning activities.

## VII. USEFUL LINKS

### Learners :

In this section, you will find links that you will need to complete this module. You should not access them right away. Instead, we encourage you to briefly read over their descriptions and move on to the next section.

### Instructors :

The links placed here introduce learners to the resources available to them in order to complete this module. As their instructor you should encourage the students to read the descriptions provided before moving on to the learning activities.

### Useful links # 1

Educ - Portfolio

[www.eduportfolio.or](http://www.eduportfolio.or)

## IV. KEY CONCEPTS (GLOSSARY)



### DESCRIPTION

Edu-portfolio is a website which presents, in a clear and straightforward manner, a virtual portfolio a very important training tool in distance learning.

### RATIONALE

A secure method for organising work is primary to success in an open and distance learning program. A portal through which to archive content, in addition to a discussion platform, makes for a dynamic educational environment.

Useful Links # 2

UneSco Bangkok : ICT Resources for Teachers CD-ROM

<http://www.unescobkk.org/index.php?id=3871>



### DESCRIPTION

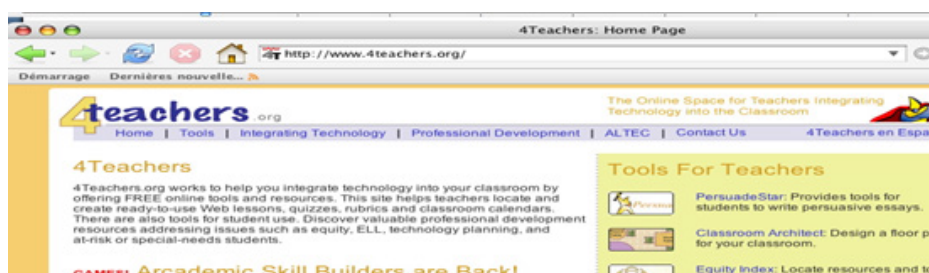
This site Web provides access to the very educational resources for teachers to aid use of ICT in their science lessons. ICT Resources For Teachers CD-ROM contains a set of ICT-based resources for teaching and learning of science, mathematics, for secondary-level students, including simulations, video clips, interactive learning objects for quizzes, animation, and other kinds of multimedia learning activities. The materials and lesson plans provided here are organized and are relevant to your subject matter discipline. A separate directory is provided to give an overall view of the types of resources available.

### RATIONALE

The success of the pedagogical integration of ICT in teaching and learning largely depends on the availability of resources to bring to life important aspects of the training content. This site hosts a number of resources, which could help educators fill-out, enrich their lessons, and make them more exciting and interesting.. This UNESCO website is worth a visit because it provides a collection of these resources for learning chemistry.

Useful links # 3

4 Teachers : Home Page



### DESCRIPTION

4Teachers.org works to help you integrate technology into your classroom by offering FREE online tools and resources. This site helps teachers locate and create ready-to-use Web lessons, quizzes, rubrics and classroom calendars. There are also tools for student use. Here you will find resources to help you integrate technology into your curriculum, along with links to stories written by teachers who personally conquered integration challenges.

### RATIONALE

Online learning is facilitated when available resources include a variety of multimedia resources and examples that help to make learning more interactive and personal. Additionally, when these resources involve real-life experiences of curriculum-technology integration, they encourage educators to discover new ways of doing things and which go to enhance their continuing professional development.

Useful link # 4

Education World: The Educators Best Friend

<http://www.education-world.com/>





## IV. KEY CONCEPTS (GLOSSARY)

### DESCRIPTION

The Website provides free featuring collaborative projects, virtual field trips, educational games, and other interactive activities.

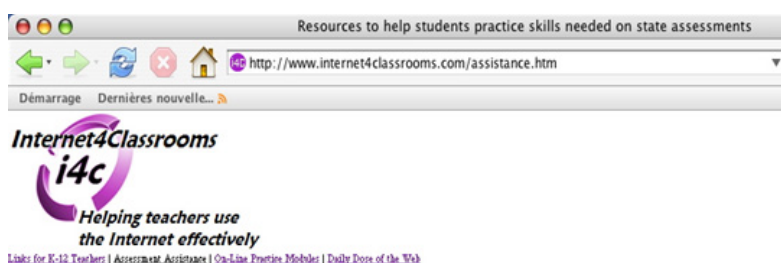
### RATIONALE

Problem-based and collaborative learning are standard pedagogical approaches in Open and distance learning. It is thus appropriate that learners and educators in the field visit this site, where projects and interesting interactive activities are available.

Useful links # 5

Resources to help students practice skills needed on state assessments

<http://www.internet4classrooms.com/>



### DESCRIPTION

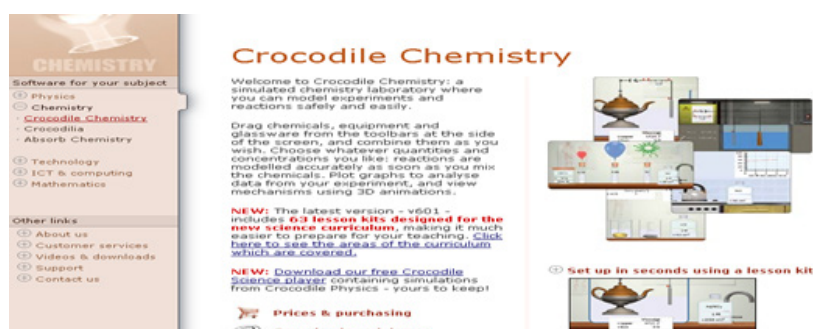
This Website provides resources to help students practice skills required on various assessments. Online Modules are available for elementary, Middle and high school students' assistance.

### RATIONALE

The Internet holds an increasingly important place in schools. Because they are considered role models teachers must not fall behind their student's ability to use email and navigators. ICT use generally, and the Internet in particular, requires at least basic competencies. Internet4Classrooms provides a portal that reviews material to assist educators in effectively using the Internet.

Useful links # 6

<http://www.crocodile-clips.com>



### DESCRIPTION

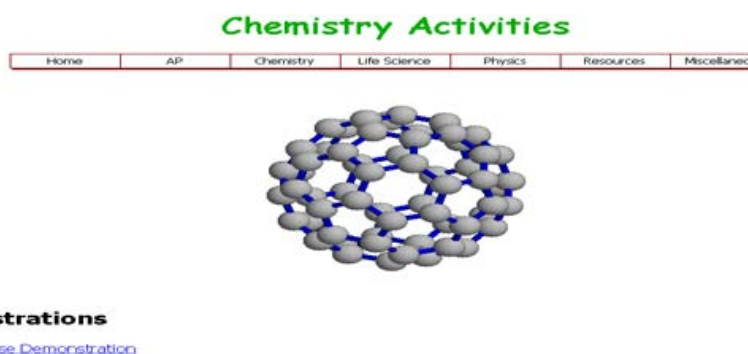
This website provides a number of free set of simulations which are available to download. It lets you open, run and interact a set of chemistry simulations that have been enabled for use. Incorporating graphic software for instance, into chemistry courses has been found to foster understanding of molecular 3D structure, and spatial ability and to promote meaningful learning.

### RATIONALE

Difficulties in learning chemistry are attributed mainly to its abstract, unobservable, particulate basis and the ability to relate across the three identified levels of chemistry understanding namely-the macroscopic, the microscopic and the symbolic world of chemistry. With the advent of computer graphics software, Computerized Molecular Modelling (CMM), and simulated chemistry laboratories have become tenable. This is a very useful site that provides a simulated chemistry laboratory where you can model experiments and reactions, plot graphs, view mechanisms using 3D animations, view lesson kits designed for various topics in chemistry, and which can then be adapted for preparing your own ITC learning activities in chemistry teaching.

Useful links # 7

<http://chem.lapeer.org/Chem1Docs/Index.php>



### DESCRIPTION

This website is designed to help the chemistry teacher find useful and detailed information on various chemistry teaching and learning activities. These activities are displayed under the instructional categories of demonstrations; laboratory investigations; teaching tips, and miscellaneous. Under miscellaneous are included activities involving preparing and using worksheets, internet research exercises; power point assignment; chemical calculations etc.

### RATIONALE

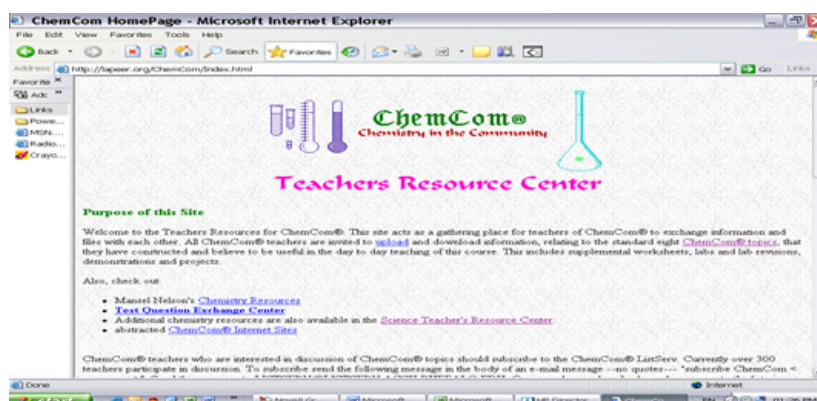
For the chemistry teacher, familiarity with a range of learning and teaching activities in chemistry is a foremost pre-condition among others, for successful ICT integration into the chemistry curriculum. In addition to providing demonstrations, labs and other information which teachers/users can access in chemistry, this website also provides useful information on ICT integration and teaching tips.

## IV. KEY CONCEPTS (GLOSSARY)

Useful links # 8

<http://lapeer.org/ChemCom/Index.html>

<http://chem.lapeer.org>



### DESCRIPTION

This web site is for /chemistry/science teachers to share ideas and exchange information. Permission is given to use and reproduce all materials at the site as long as the activities are not sold.

### RATIONALE

This chemistry teachers' resource website is an easy-access source for a variety of chemistry teaching and learning activities on the Internet. There is plenty of useful computer assisted materials for chemistry teaching available, it is just a matter of finding what is relevant to your needs.

# VIII. LEARNING ACTIVITIES

## 8.1. Learning activity # 1

To note : Reading is an especially important activity in Open and distance learning. To best grasp the concepts of the pedagogical integration of ICT, the readings for each activity are compulsory. Two texts accompany activities #1.1 and #1.4, and a single text for #1.2 and #1.3

### Learning activity # 1.1

Title of the learning activity: Reading critique

Read thoroughly the UNESCO (2004) text on continuing education for teachers, and the integration of ICT in scientific disciplines (lessons-learned and best-practices for ICT in Mathematics, Biology, Physics and Chemistry teaching programs).

Reference for the compulsory reading :

UNESCO (2004). School networkings : Lessons learned. Bangkok : UNESCO Bangkok (ICT lessonslearned series, Volume II).

Detailed description of the activity : Suggestions for completing the assignment.

Read the UNESCO (2004) text and produce:

- A 3-page (maximum 1300 words, 1.5 line spacing) summary report. The report should clearly bring out the major points of a professional development plan that would allow teachers to succeed in integrating ICT in their discipline.
- A synthesis table presenting the basic skills necessary to apply ICT in pedagogical practices.
- An analysis of the important themes developed in the two texts, noting opportunities to integrate them in your discipline or teaching practices.

### **Formative evaluation:**

The evaluation of the learning activities is based on the quality of the learner's analyses, arguments, and examples, and the depth, richness and and variety of their ideas. As well, the structure of the submitted work, how well it is organised, its style and language and presentation, are important. In line with these expectations, the evaluation of this activity will be weighted as following:

Summary report (40%)

Synthesis table of basic ICT skills (30%)

Analysis and opportunities for integration (30%)

### Learning activity # 1.2

Title of the learning activity: Creation of a trainer profile in distance learning.

## VIII. LEARNING ACTIVITIES

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UNESCO (2002). Teacher Education Guidelines : Using open and distance learning. Education sector, Higher Education Division, Teacher Education Section in cooperation with E-9 Initiative.

### Summary of the learning activity:

Fundamentals concerning the use of ICT by teachers in the context of Open and distance learning.

Detailed description of the activity: Suggestions for completing the assignment.

Having read the UNESCO (2004) text (ref. lesson activity 1.1):

- Write a brief critique (600 words, or two pages at 1.5 line spacing) responding to the major challenges faced by teachers in Open and distance learning, as presented in the text.
- Illustrate, in a table, the competencies required of, and the ideal profile for, an Open and distance learning educator.

### Formative evaluation

The evaluation of this activity will focus on both content and presentation. 60% will be dedicated to the quality of the analysis, and 40% to its presentation, particularly the competency table.

### Learning activity # 1.3

Title of the learning activity : Reading critique.

Tchameni Ngamo S. (2006). Pedagogical Principles and Theories of integration of ICT in Education. AVU Teacher Education Authoring content Workshop. Nairobi - Kenya, 21st August to 2nd September

### Summary of the learning activity:

The theories and guiding principles of the pedagogical integration of ICT in education.

Detailed description of learning activity: Suggestions for completing the assignment.

Read thoroughly the text on the fundamentals of ICT integration in education, and write a report that briefly (in two pages, 1.5 line spacing) presents the important aspects of ICT integration, as outlined in the document.

In an additional section, critique the text, and relate its themes to professional development for educators.

### Formative evaluation:

The evaluation of the learning activities is based on the quality of the learner's analyses, arguments, and examples, and the depth, richness and variety of their ideas. As well, the structure of the submitted work, how well it is organised, its style and language and presentation, are important. In line with these expectations, the evaluation of this activity will be weighted as following:

Report on the reading (50%)

Critical analysis and link to professional development (50%)

### Learning Activity # 1.4

Title of the learning activity : ICT impact “success stories”.

#### **Reference for the reading:**

Becta (2005). The Becta Review 2005 : Evidence on the progress of ICT in Education. Becta ICT Research

#### Summary of the learning activity:

Various positive impacts of ICT use in mathematics and science.

Detailed description of the activity: Suggestions for completing the assignment.

Begin by reading the two Becta (2005) texts on the evidence of positive impacts of ICT on learning, then:

Write a one-page synthesis report and create a PowerPoint presentation on the positive impacts of ICT on the process of learning.

Present two success-stories related to teaching using ICT (or two personal accounts of the same). Note links to the advantages outlined in the text. The accounts must highlight the important lessons to be learned (while noting significant risks and challenges).

#### Formative evaluation

The evaluation of the learning activities is based on the quality of the learner’s analyses, arguments, and examples, and the depth, richness and variety of their ideas. As well, the structure of the submitted work, how well it is organised, its style and language and presentation, are important. In line with these expectations, the evaluation of this activity will be weighted as following:

- Production of the synthesis report and PowerPoint presentation (50%)
- Presentation of success-stories/accounts (50%)

## **8.2 Learning activity # 2**

Detail description of the activity: Suggestions for completing the assignment.

Choose two readings available on the Internet, draw from them two opposing or contradictory scientific opinions. Now report (in 600 words, about two pages) information from various sources what does this demonstrate? For example – both Darwin’s theory of evolution and Creationism are found on Wikipedia ([www.wikipedia.org](http://www.wikipedia.org)). Your report should conclude by drawing out the challenges you may face in this context, as a teacher working with students.

### Formative evaluation:

The authenticity of the readings (20%)

The brief resume of the two texts (40%)

The critical analysis of the readings (20%)

Presentation of the material, within the defined parameters the assignment (20%)

### **8.3. Learning Activity # 3**

(ICT IN CHEMISTRY)

To Note: There are many opportunities for integrating ICT into aspects of the chemistry curriculum. It is important that ICT is used thoughtfully, in a way that enhances learning in chemistry, and introduces or consolidates ICT skills to students, for improved quality of teaching and learning.

Compulsory readings 7, 10 and 11 accompany all the activities in 3.1- 3.3.

Before using an ICT resource you will need to evaluate it. Try it out yourself, or read about it, in order to identify the strengths and weaknesses and see how it might support your teaching aims in chemistry. Below are some questions to help you in your choice of ICT-based resource.

#### **The design**

1. Do you think your pupils will find it easy to use ?
2. Can the pupils use it on their own i.e. independently?
3. Is it straightforward to enter data or instructions?
4. Does it give immediate feedback, if so in what form and to what end?
5. Can you adapt it to suit the needs of the pupils within the context of the resources available to you?

#### **The content**

1. Are there useful support materials which come with the package, consistent with the learning outcomes of the lesson?
2. Is the language and information suitable for the special needs of the pupils you are teaching or hope to teach?
3. Is it relevant to your scheme of work?

What links are offered to other sites? (web sites only)

#### **Teaching and Learning**

1. How long will it retain pupils' attention, interest and motivation?
2. Does it support active learner participation and development of higher order thinking and problem solving skills?

3. Will it support the learning of less academically motivated pupils?
4. Can it extend the learning of highly able pupils?
5. Will it support and enhance teaching? In what way?
6. Will it support and enhance learning? In what way?

The following websites:

- <https://www.ase.org.uk/.../school-science.../06/.../SSR309Jun2003p53.pdf>
- Becta: [www.becta.org.uk](http://www.becta.org.uk)
- Curriculum Online: [www.curriculumonline.gov.uk](http://www.curriculumonline.gov.uk)
- Schools' Observatory website:  
• [www.schoolsobservatory.org.uk](http://www.schoolsobservatory.org.uk)
- Science Year CD-ROMs: [www.sycd.co.uk](http://www.sycd.co.uk)
- Teem: [www.teem.org.uk](http://www.teem.org.uk)

For secondary science include discussions on aspects of ICT use in science that might be useful in addressing some of the questions raised, and the challenges that you may meet in relating the requirements of chemistry and ICT. You will need to access and read them.

**Title of learning activity:**

Working with spreadsheets, data-loggers and graph drawing software to organise display and interpret collected data in chemistry.



### Summary of learning activity:

Using spreadsheets to explore relationships in experimental data in chemistry.

Chemical Excelets: Interactive Excel Spreadsheets for General Chemistry: [http://academic.pgcc.edu/~ssinex/excelets/chem\\_excelets.htm](http://academic.pgcc.edu/~ssinex/excelets/chem_excelets.htm)

These interactive spreadsheets (aka - simulations) are used in-class and as out-of-class projects. Through the use of numerical experimentation and "what if" scenarios, we have a powerful discovery learning tool for students using readily available off-the-shelf software. See below website for detailed description of various activities:

Sinex, S.A. (2007c) Developer's Guide to Excelets: Dynamic and Interactive Visualization with "Javaless" Applets or Interactive Excel Spreadsheets, <http://academic.pgcc.edu/~ssinex/excelets>. (accessed 22 March 2016).

In chemistry, ICT can be an effective tool in teaching and learning when it is used by learners and/ or teachers to interface with pieces of scientific equipment so that measurements can be made and data logged for later use.

The central features of practical activity in chemistry have always been observation and measurement. For this reason, students are exposed to a variety of instruments that can observe and measure. The collection of the results of observation and measurement is known as data; and when processed are usually presented in graph or tabular form.

In chemistry, students are often required to make predictions about relationships between continuous variables and to quantify such relationships. Graphs and spreadsheets are particularly useful for such data displays and presentations. For example, students can use spreadsheets to tabulate and calculate results of experiments for individual or group work.

### Learning activity # 3.1 Working with spreadsheets

You already know what a spreadsheet is. You are familiar with its concept and its components, and are able to make use of a prepared spreadsheet to change values of variables and to observe their various effects.

The use of spreadsheets is the clearest and quickest way to demonstrate how manipulating a particular variable produces certain effects. They are useful tools for individual or group work in the chemistry classroom. Various types of bar charts and line graphs can be plotted from values entered into a spreadsheet.

(Fig below illustrates a template of a simple lesson format in the use of spreadsheet)

|   |                   |
|---|-------------------|
| ICT INTEGRATION   | Year Group:       |
| Using a spreadsheet to explore relationships in experimental data | Resources         |
|   | Spreadsheet       |
|   | Science equipment |

**Context**

It is assumed that your students have some experience of using spreadsheets from mathematics lessons, including the use of graphs.

**Task Description**

Students, working in groups record data from the experiment on factors affecting reaction rates.

The spreadsheet is used to produce graphs and explore the relationship between changes in the concentration of reactants in solution and the rate of reaction at constant temperature.

**Specific Learning Outcomes**

| Chemistry Knowledge and Understanding   | ICT Skills, Knowledge and Understanding  | ICT level |
|---|--|-----------|
| Students provide simple explanations why chemical reactions proceed at different rates.                         | They make appropriate choices when using ICT-based models or simulations to help them solve a problem. |           |
| They describe some methods of monitoring rates of reactions and the parameters involved in such investigations. | They use ICT-based models and simulations to explore patterns and relationships, and make predictions. |           |
| They determine the factors affecting the rates of chemical reactions.   | They explore the effects of changing the variables in an ICT-based model.                              |           |
| Chemistry learning outcomes related to task:  | ICT learning outcomes related to task:   |           |

## VIII. LEARNING ACTIVITIES

### Teaching Approach

Undertake a pre-activity discussion in which the whole class is reminded about spreadsheets and graphing. Students work in group collecting experimental data then individually or skill in groups, entering it in the spreadsheet in a template or new worksheet, producing graphs. Mixed ability groups will allow pupils to share expertise with spreadsheets and support each other.

### Links with other curriculum areas

Possible links to maths and numeracy in handling data

### Forms of Assessment

|                        |                      |                               |
|------------------------|----------------------|-------------------------------|
| Teacher<br>Observation | Peer/Self Assessment | Teacher/Student<br>Discussion |
|------------------------|----------------------|-------------------------------|

Students are introduced to the concept of a spreadsheet and its components. They are to manipulate a prepared spreadsheet by changing values in cells of the different parameters or variables. For example, the variables in a chemical formula or mathematical equation can be rearranged or changed to see the effects of making any of the variables the subject of the equation. Graphs based on the values entered in the cells can also be generated automatically using the appropriate software. The students should also be made aware of the various uses of spreadsheets in commerce, industry and daily tasks.

You can request from your lecturer/instructor, various types of graphs and bar charts to be plotted from values entered into a spreadsheet. Spreadsheets have the advantage that most software programmes can easily accept and manipulate information from databases and can create output graphics.

### Assignment and Assessment

For your assignment: First, identify a list of areas, topics or experimental work in school chemistry where the use of spreadsheets would be particularly useful and applicable.

Second, your instructor may have prepared templates (or access one yourself) that have values already entered to illustrate effects of manipulating variables, (changing values in cells). Use a prepared spreadsheet to change values in cells and some chemistry formulas or variables, to demonstrate how manipulating a particular variable produces certain effects. Working with spreadsheets to illustrate effects of manipulating variables is most appropriate for work on simulation and modelling.

Thirdly, design and create a simple spreadsheet for an activity lesson for use to accept and calculate the results of a chemistry laboratory experiment that you have identified for a particular grade level. Use an ICT integrated chemistry lesson format to present the lesson.

You will need a computer, spreadsheet software and/or access to teacher prepared or readymade spreadsheets.

### Formative evaluation:

1. the identification of the topics in chemistry suitable for the use of spreadsheets (20 marks)
2. The process of designing the spreadsheet (50marks): headings of columns and rows
3. the varying width of columns
4. the allocation of values and units of measurement to columns
5. the creation and copying of formulas
6. the rearranging of entries (rows) and columns
7. the import of information from a variety of sources
8. the export of information to a variety of destinations
9. Presentation of the material (experimental work) in lesson plan form (30 marks)

### Working with Simulations and Modelling

When teaching and explaining some chemical concepts, principles or phenomena in schools, teacher presentations are often made in an excessive 'chalk and talk' (didactic) way. To tackle this problem, even at an elementary level, the modeling of a simple chemical situation allows or requires one to balance deductive aspects with an exploratory approach (simulation versus modeling). Such teaching approaches seek to bridge or marry the experimental with the theoretical.

A good introduction of simulation and modeling in chemistry would be to simulate and experiment with an already solved problem (an existing scientific model). Examples of such scientific models include radioactive decay, change in pH-values. Many computer games are simulations and some of these are based on particular scientific, engineering or economic models. When students have performed or have witnessed a demonstration, repeating the experience through modeling will give them further insight into the role of variables and parameters in a process. Examples of such simulation and modelling are pollution effects (air, land or water) on the environment, the supply and demand of goods.

Although many different approaches to simulation and modelling are possible depending on the choice and availability of tools, it is essential when teaching school chemistry to limit oneself to simple models even for complex processes.

## VIII. LEARNING ACTIVITIES

From concrete and very often visual observations students can build up an outline of a system that allows them to reproduce the observed behaviour in an adequate manner. Students can try out models on a spreadsheet (See lesson plan below) or using a special modelling tool if available. The minimum resources required are a computer per student or group of students, modelling software or a specific simulation programme.

Typically the user/student will be able to adjust a small number of parameters, for example in a simulated experiment but cannot alter the mathematical algorithm, which uses those values. Typically dangerous or expensive experiments will best be performed through simulations. For examples see below for existing commercial software:

|   |  |
|---|--|
| Crocodile Clips (See useful links)  | Simulation packages for Chemistry, with free demos available from the web site |
| <a href="http://www.dlt.ncssm.edu/TIGER/chem3.htm">http://www.dlt.ncssm.edu/TIGER/chem3.htm</a> | Simulation, and modelling packages of an online chemistry course.              |

Other computer-assisted learning software written specifically for learning in science are readily available. This will include simulations but also specific CD-ROMs, revision programs and web sites.

The useful links section contain a few examples that illustrate a great deal of good generic software available:

Collecting and analysing data (databases such as Appleworks database, Microsoft Access or Information Finder and spreadsheets such as Microsoft Excel and Appleworks spreadsheet)

Modelling (spreadsheets such as Microsoft Excel and Appleworks spreadsheet)

Communicating (Internet electronic mail and the world wide web)

Example of an activity description lesson plan in the use of simulation

|  |                                  |
|--|----------------------------------|
| <b>ICT Integration</b>   | <b>Year Group:</b>               |
| Using a simulation to explore the relationships in experimental data | Resources<br>Simulation software |

### Context

Students have some experience of using computers, possibly having used simple simulations.

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**Content**

Students, working in pairs or individually use a simulation and record data from an experiment in which the volume of oxygen in sodium hydrogencarbonate solutions containing pond weed, over a fixed period is measured under differing lighting conditions (given by the position of a lamp).

The simulation may be used with a spreadsheet to produce graphs and explore the relationship between light intensity, medium and volume of oxygen produced over a fixed time.

| Science Knowledge and Understanding  | ICT Skills, Knowledge and Understanding                                   | ICT level |
|--|---|-----------|
| Pupils demonstrate an increasing knowledge and understanding of life processes and living things .. They describe the main functions of organs .. of the plant   | They explore the effects of changing the variables in an ICT-based model. | 5         |
| Pupils use knowledge and understanding of life processes and living things .. to make links between life processes in animals and plants and the organ systems involved. They explain the processes of respiration and photosynthesis in terms of the main underlying chemical change. | They use ICT to measure, record and analyse physical variables.           | 7         |

## VIII. LEARNING ACTIVITIES

|  |   |   |
|--|---|---|
| Pupils demonstrate an extensive knowledge and understanding of life processes and living things .. by describing and explaining how biological systems function. .. They recognise, predict and explain changes in biological systems. | Pupils independently select appropriate information sources and ICT tools for specific tasks, taking into account ease of use and suitability. They design successful ways to collect and prepare information for processing. | 8 |
| Science learning outcome related to task:  | ICT learning outcome related to task:   |   |

### Teaching Approach

Students work in groups of two or individually collecting experimental data from the simulation, entering it in the spreadsheet and producing graphs. Mixed ability groups will allow pupils to share expertise with spreadsheets and support each other.

### **Links with other curriculum areas**

### **Possible links to maths and numeracy in handling data.**

### Forms of Assessment

|             |                      |               |
|-------------|----------------------|---------------|
| Teacher     | Peer/Self Assessment | Teacher/Child |
| Observation |                      | Discussion    |

### Assignment and Assessment

This is a decision-making exercise in which decisions have to be made on the basis of chemical knowledge as well as geographical economic and even moral grounds.

The desired objectives are that you the student should be able to:

- Appreciate the consequences of a chemical decision in social, economic and human terms
- Use chemical literature efficiently and critically
- Argue logically in presenting or defending a proposal , both in oral and written form
- Make decisions that can be defended even with inadequate or insufficient information

### Project

Here is an hypothetical project/problem in which you have to raise some questions and make decisions in order to address the problem

"A large (but alas mythical) find of common salt is reported in Johannesburg, South Africa".

Decision 1. What can it be exploited for in chemical terms? Argument leads to suggestions of NaOH, Na<sub>2</sub>CO<sub>3</sub>, Cl<sub>2</sub> etc

Decision 2. By what processes can this be done? What raw materials are necessary? Where should the factory be sited-on the salt field or on the coal field? From the demand and supply trend figures, how big should the factory be and what will it cost?

Decision 3. If we take one commodity (e.g. Na<sub>2</sub>CO<sub>3</sub>) how much will it cost to produce it by the processes suggested in terms of raw materials, wages of factory workers etc?

Decision 4. What effect on the economics has the selling of by-products?

Decision 5. What ecological problems will the factory cause? Can they be eliminated, reduced to acceptable levels?

This exercise is meant to give you experience in logical and sequential argument, in weighing up variables and relating them, in deciding upon tolerable limits of cost, pollution, employment etc based on simulation and modelling. The simple chemical equations are seen to have significance far beyond the textbook or the laboratory.

### Formative evaluation

The students should be assessed on their ability to identify the main parameters of the chemical situation or event, formalize a model by modelling the situation with a small number of parameters, then explore it (model), interpret the results and determine how the model fits with reality.

## Learning Activity # 3.2

Title of learning activity: Working with a database

Summary of learning activity: Application of databases in chemistry

### Detailed description of activity:

In a variety of businesses and in everyday life computer technology is widely used for data-gathering and storage purposes. Data are stored in databases managed by computers, which are increasingly being linked together, for example for airline and hotel reservations. More and more information about people, about subject matter, about events, etc is stored in databases.

In this activity you will be required to create and use databases for storing information or variables in chemistry and then carefully examine these data bases to find relationships and commonalities, in terms of say structure and the corresponding properties and function.



## VIII. LEARNING ACTIVITIES

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### Assignment

As a first step, try to prepare an appropriate structure of a database for any chemistry example, into which data can be added. Variables such as:

- the characteristics of chemical elements in the periodic table;
- the characteristic structure and properties of the functional groups in organic compounds

But before preparing an appropriate database you need to understand some of the relevant steps in problem solving, which include such stages as design, data entry and modification, etc; and then identify a problem in chemistry that can be solved by a database.

Design and create a database to enter and store chemical information into which you can add data.

### Formative evaluation

the identification of the chemistry topic(s) suitable for the application of database

the demonstration of an understanding of the relevant phases of problem solving

the ability to create and/or use prepared database to store information/ variables, (for example, the characteristics of chemical elements in the periodic table)

the ability to draw and interpret these databases to find relationships and commonalities in a structured and rational manner.

Other Important links for lesson ideas

Genetic Variation (modelling)

A different approach to building up ICT skills within the science curriculum is to familiarise oneself with various resource pack . A free resource pack the genetic variation has been produced that includes help on writing lesson plans and other useful information.

### **Learning activity # 3.3**

Title of learning activity: Data logging

Summary of learning activity: The use of ICT tool for the measurement, collection and processing of chemical data.

Detailed description of activity

Modern computer technology can now assist in the handling and processing of experimental data in chemistry. This process is referred to as datalogging. Students can use a word processor to report on the results of experiments or research they conduct. In chemistry, they can also use data and graphs created from measurement software.

Experimentation and measurement in chemistry is one of the principal means for guided discovery learning, and for knowledge construction based on experience.

Computer-aided datalogging has given rise to new approaches in chemistry practical work.

The basic parts of a computer-aided datalogging system or an ICT measurement system are shown in the figure below. Provide a figure as an exercise in the appropriate space.

The system includes: the input(sensors), processor(computer), output(software-graphs, tables, data handling).

A sensor is a device that is able to respond to the physical property of the environment. Sensors detect variables or changes in the physical properties of : sound, conductivity, force, oxygen, heat flow, voltage, pH, light and light gates, temperature, differential gas pressure, barometric pressure, electrical current, angular displacement, humidity, magnetic flux density, blood flow, radioactive decay, acceleration.

A wide variety of sensors exist and they are used for recording data automatically. A list of some of the sensors required for teaching secondary school chemistry are given; Temperature Sensor, pH sensor; Colorimeter sensor; High range Temperature sensor; Voltage sensor;; Light Sensor; Conductivity sensor, Absolute sensor pressure.

Most ICT measurement systems include both hardware, which will include an interface unit, and software although generic software is available (see Data Harvest , and Logotron). There are free educational resources available on the Logotron website. You can find and download a range of curriculum based topics full of suggestions on how the available and relevant software can benefit your classroom.

The function of the interface unit, which is similar to a modem is to convert the voltage signal of the sensor to a digital signal which can be read by the computer. It can be programmed to collect data automatically. And is especially useful for logging data over extended periods.

The sensors, interface unit computer and appropriate computer software comprise what is commonly called datalogging system.

Specialised computer software is required so that the computer can interpret and process the signals from the interface unit. The software usually allows graphs to be produced.

From a teaching perspective, one of the major advantages of modern computer-assisted datalogging is that the software captures and instantly graphs the data. This allows the students to concentrate on scientific inquiry and the development of problem-solving skills. This "real-time" graphing encourages group discussion on the progress of the experiment and provides for more higher order thinking.

Pupils and students should be able to perform simple computerized measurements on a practical chemistry experiment, process experimental data and draw conclusions from those data.

With the appropriate software and the necessary resources (One computer per group of students; measurement interface and sensors., specific software for measuring) a good introduction would be to demonstrate measurement in a chemistry laboratory experiment.

The real benefits of datalogging come from immediate observations of the data, asking questions about them, looking for links with other information, making comparisons, making

predictions, looking for trends and so on. Its use in both teacher demonstration and pupil or student activity is likely to have very positive effect on learning outcomes.

### Assignment and Assessment

1. You are to find out from a survey of the educational literature available on the Internet, the chief advantages of data logging in chemistry education. You are to present and discuss your findings under the following sub-headings: (i) Ease of capture of data; (ii) Speed of capture; (iii) Better learning outcomes (iv) Presentation of experimental data; (v) Appreciation of modern technology; (vi) Increased level of interest among students; (vii) Encouragement of active learning and (viii) Mixed ability teaching.
2. Identify and list 20 areas or topics of the school chemistry syllabus in which data-logging equipment has been and/or can be used.
3. Write two experiments in school chemistry for which a particular brand of data-logging equipment could be used. Go on an Internet search for a template (or develop one) to illustrate the format to be applied for writing up the details of the experiments. Include your lesson plan and assessment scheme, and your lesson evaluation.

Note, that managing the use of ICT in a science laboratory, especially when carrying out datalogging, produces particular problems. Some dataloggers allow you to collect data remotely and then connect to the computer later to download and process the data. Notebook or palmtop computers are an alternative to large desktop units for using near apparatus. You will need to assess what ICT equipment is available to you and how to use it safely in a hazardous environment.

### Formative Evaluation

The assessment will be two fold: the first will be based on your knowledge of the system elements of an ICT measurement system and what research says about the effectiveness of data-logging in teaching chemistry at secondary level; and secondly, the ability (during contact session) to perform simple computerized measurements on a wide range of experiments in chemistry laboratory work, process the experimental data and draw conclusions from them using the most suitable data-logging system.

### **8.4 Learning Activity # 4**

(Information and Communication in Chemistry)

Title of the learning activity: Use of ICT in project-based learning in chemistry

Detailed description of the activity:

You will need to first to read the compulsory readings 8 and 9.

Over the past decade science educators have been engaged in experimental projects that focus on the integration of ICT-the Internet and the World Wide Web in particular as

an additional medium for teaching and learning. Project-based learning (PBL), which is increasingly supported by ICT, is said to contribute to enhancing student-directed inquiry learning in a real world setting. (For more detailed exposition of PBL see Barak & Dozi 2004)

In an IT environment, students can use ICT-based tools such as a word processor or presentation software to report on the results of experiments, present a research project or communicate with other students. Also, for research projects and specific assignments, the Internet can be used as a source of scientific data and theoretical information.

This learning activity is about the integration of Project-based learning in an IT environment into chemistry teaching, using the Internet as the learning environment.

### Assignment and Assessment

The ICT project-based assignments that we shall outline in this activity are premised on the constructivist perspective emphasizing active learning and higher order thinking skills. They should serve as exemplars for the student teacher. They require solving real-life problems, seeking information on the Web, exploring chemical concepts and theories, and presenting arguments.

As part of the PBL approach, each assignment is hands on, demands authentic investigation of the presented concept, and the use of ICT-based cognitive tool- the Internet to support the process of inquiry.

The two assignments given as examples here are to be carried out individually. The resources needed are computer and access to Internet.

The two are titled 'Elements in the periodic table' and 'Scientific theories'.

The first assignment, Elements in the periodic table, takes the investigative form of asking the student to identify a chemical element in a riddle by investigating the periodic table and seeking information using the Web.

The riddle for such an inquiry is this : "I can be found in batteries and coloured old glasses, but not in pencils anymore, I am known for my high density and I am poisonous who am I?"

(the answer is lead Pb)

The students are asked to identify the element and present information regarding the date, place, and the way the element was discovered. They are also required to present an image or visualization of the element, its chemical and physical properties and its daily use and applications. Furthermore they may be required to make use of online data including readily available easy-to-use applets to identify and perhaps simulate all kinds of processes and phenomena relevant to the investigation. Individuals or groups of students may be asked to investigate different chemical substances.

The second assignment, Scientific theories is concerned with the complex process of accepting or rejecting a scientific theory. The students may be required to investigate the principles of a given theory in chemistry and to explain why it was accepted or rejected by the scientific community.

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In this assignment each or a group of students will receive a different theory. Some theories such as cold-fusion and poly-water fell by the wayside, i.e. rejected, while others, such as molecular orbitals, quantum theory, acid-base by Lewis, and Schrodinger's atom model are accepted.

Collaboration among students is likely to occur in the search and downloading of information relevant to the task at hand. Students should be able to demonstrate how one can communicate, exchange and collaborate within an ICT network; send and receive messages and documents by using email facilities; retrieve information by navigating, searching, and selecting information from the Internet and the World Wide Web; be critical about the quality of information available, and acknowledge the ownership and private aspects of information; and identify the various methods and types of activities of communicating via a network. At the end of the project, the teacher may want the students to share the knowledge they had acquired by asking them to upload their projects to the course Web site for the benefit of all classmates.

### Formative Evaluation

The PBL in chemistry may be evaluated both quantitatively and qualitatively. The quantitative component may take the form of a pre- and post-test of students' prior knowledge in the areas to be covered.

The qualitative evaluation may focus on content analysis of the students' projects in which qualitative interpretations will be constructed gradually from the presentation. First, the students' answers to the inquiry based questions will be processed and analyzed listing concepts, words and arguments they used. Second, conceptual categories of chemistry understanding will of necessity be generated from the write-ups (to be supplemented by interviews perhaps) to determine meanings and relationships of concepts. Third, the issue of how critical the students were in terms of evaluating the quality and relevance of all information retrieved and the ability to cite and reference sources correctly when reporting will be factored in. Finally, a summary of the instructor's/teacher's insights into the investigated project will be produced.

### **8.5 Learning Activity # 5**

(Problem solving in computer assisted instruction)

Summary of learning activity: One important aspect of chemistry education is problem solving. By learning skills in problem solving, besides acquiring a better understanding in the subject, student acquire methods of thought that will enable them to "create" science, and gives them a sense of confidence of having mastered a subject. Important as it is, problem solving is often a poorly achieved goal. Computer assisted instruction can be quite useful since problem solving involves a well-structured sequence of steps and a computer program is just that.

Detailed description of the activity: The computer can simulate the role of the teacher guiding the student or pupil in the uphill ascent of solving a chemistry problem or task. A model of problem solving in chemistry identifies four stages in the problem solving process of bridging the gap between what is given and what is required.

### **These 4 stages are described as follows:**

Stage 1: Definition of the problem-here the process entails defining the objectives or goal(s) clearly; rephrasing the problem into one or more questions, and subdividing the problem into smaller problems

Stage 2. Select appropriate information-here this stage involves selecting relevant pieces of information, which may be needed or incorporated into the solution. This information may be derived either from the problem statement or from memory.

Stage 3. Combine separate pieces of information-This is a crucial stage in which the individual pieces of information are combined or assembled in order to arrive at new knowledge or new pieces of information. This is the reasoning stage that is essential to arrive finally at the solution.

Stage 4. Evaluate. The final stage, the evaluation is to assure that the solution is a reasonable solution to the problem stated and is consistent with the information given and the units.

### **How is a computer useful in these stages?**

Stage 1-the screen may be used to propose a problem to the student. A screen display takes the place of the blackboard. The computer may offer the student hints, by rephrasing the problem, or underlining key concepts or words or sentences, offering a graph etc. When these helps are given, the student may be penalised by having his/her score reduced. In this way hints will only be requested for when really needed. The assistance offered by the computer is meant to help the student to come out of a deadlock and to teach him or her how to tackle similar-type problems next time.

Stage 2 is meant to provide the building blocks for the solution. These elements will be derived from the problem statement (the data given) and memory (knowledge acquired from theory or practical class). At this stage the computer may display the known data and offer possible relevant information from which the student could choose, such as tables called by pressing a given key, or information in the form of multiple choice questions.

Stage 3 the student must undertake the synthetic work of combining the two types of relevant information (external information and information from memory) so as to arrive at the solution.

The network approach to problem solving in chemistry has been proposed as a systematic procedure for solving problems, especially at this stage. Let us illustrate

Information may be classified into the following types:

◇ -data given

information from memory

information from reasoning

solution:

Information items are combined by key relations, which result from laws, formulas equations definitions etc.

## VIII. LEARNING ACTIVITIES

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### Example

An object has mass 1 kg: find its weight.

Information from problem is mass of object = 1kg

Information from memory is acceleration (a) due to gravity  $g = 9.8 \text{ m/s}^2$  and the fact that weight is the force of attraction of gravity.

The key relation is Newton's law  $F=ma$ .

Thus force (F) = weight (mass x acceleration) =  $1\text{kg} \times 9.8 \text{ m/s}^2 = 9.8\text{N}$

The corresponding network is shown below:

◇ -data given is mass = 1kg

○-information from memory: force= mass x acceleration

○-information from memory acceleration of gravity =  $9.8\text{m/s}^2$

Networks are very useful since they break down problems into pieces of information and reassemble them to show how the various types of data have to be connected in order to arrive at a solution to the problem. This analytical/synthetical approach is essential in forming the minds of science students.

In many problems in chemistry the vital hint required is the key relation since problem solving is the process of bridging the gap between known and unknown quantities using appropriate relationships: laws, formulas, definitions. A computer may conveniently display a table containing such relations at the student's request

At stage 4 the computer may easily be programmed to verify the numerical solution and to display a positive remark such as Bravo!! for a correct solution.

### Assignment

Due to its difficulty the quality of some existing problem-solving software in chemistry for micros is not very high. Keeping in mind that a computer is just a teaching aid, not a substitute for the teacher, what subject matter content and pedagogical content knowledge in chemistry will you take into account in assessing the quality of a problem solving chemistry software for use with a specified grade level in a school? Use the following guideline for your presentation:

Key questions to ask when assessing:

- a. What do you want to assess?
- b. How will you assess?
- c. How will you collect evidence?
- d. How will you record achievement?

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## IX. Synthesis of the Module

Information and communication technologies facilitate worldwide contacts between teachers and students. The Internet is an excellent source of scientific data and theoretical information and offers a viable means to support authentic learning in chemistry. Discovering the scope of information available over the Web and in other ICT based cognitive tools and how to use it should be part of the undergraduate education of every chemistry student teacher. In this module, we have engaged in learning activities that focus among others, on the integration of the Internet and the World Wide Web as an additional medium for enhancing the teaching and learning of chemistry. For example, simulations can be used to develop understanding of chemical concepts in different contexts, computers can be used as research tools for inquiry-based chemistry projects.

Learners should be able, through this module, to identify the key-concepts in the process of ICT integration, and to critically engage in the required readings and use of ICT-based resources (an important skill in Open and distance learning). Examples of learning activities, which can be modified or adapted to suit specific disciplines, are provided, as are a number of useful links (illustrated with screen captures), the latter presenting pedagogical resources to guide educators and learners in their knowledge-seeking and training processes. A bibliography is provided to further support ICT in chemistry, facilitate research, lesson planning, teaching, communication, problem-solving, and professional development.

## X. Summative Evaluation

Information and communication technologies shouldn't be an 'added-on' or 'tagged-on' extra in chemistry education. Its use should be fully justified in the school chemistry scheme of work.

The following assignments are to be written up and submitted to the instructor.

Discuss how you would go about integrating ICT in your chemistry scheme of work: In your presentation I would like you to address the following issues and questions with regard to the changing competencies required of both students and teachers if they are to function effectively in today's society

What criteria would you use to measure your success in planning a scheme of work and a lesson in which ICT is used to support learning in chemistry? How will and indeed do these criteria differ from chemistry lessons in which ICT was not used?

What challenges are you likely to meet in relating the requirements of chemistry and ICT? By all accounts these might be considerable and require collaborative work and discussions with a colleague(s) or some ICT 'expert' familiar with your own particular educational environment. It is important that you do not just list challenges but also show how you intend to deal with them.

What practical measures at school level would be necessary to adopt because of incorporating ICT in your chemistry lessons?



## IX. Synthesis of the Module

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In a more general way, identify and summarize the measures and/or issues that you consider would be significant in incorporating ICT into your teaching.

1(b) For the second part of your write up, you will need to talk to teachers in the schools and/or those of your colleagues that you work with including teachers of ICT to get a sense of the skills that pupils at a given grade level actually do have.

From the discussions and consultations, address the following issues in your written submission.

- What ICT skills do you think an 'average' pupil should be able to demonstrate in their chemistry work without help, at the beginning of their secondary level chemistry syllabus and at the end? How did you arrive at that? Do you expect them given your circumstances to be ICT literate?
- What range of ICT skills do you think all your pupils in the end will be able to demonstrate?
- How would you go about addressing any deficiencies?
- In your discussion you should take into account the diverse learning needs of all your pupils.

Assessment criteria: Answer key

- The use of ICT to enhance teaching and learning in chemistry, discussed in the scheme of work, should:
- be the most effective way of achieving chemistry teaching and learning objectives, and not simply for motivation or reward sake
- be used for tasks not otherwise achievable without ICT
- ensure content is given importance over quality of presentation alone
- maximise the use of time and resources
- incorporate high expectations of students
- include, where possible, links between science and everyday applications
- ensure judgements about achievements in science are not masked by ICT
- ensure that all students cover key concepts
- ensure, when working individually or in groups, that all students are fully engaged and collaboration is balanced
- provide ICT resources for ad hoc requirements for research
- include consideration of resources availability and show concern for health and safety
- ensure ICT supports learning.

### The scheme of work related to the use of ICT must show:

- where ICT meets design and technology teaching and learning objectives
- how students' learning is directed and stimulated by using ICT
- how students' progression will be assessed and recorded
- how the impact of ICT use is managed
- how students' earlier experience and capabilities are accounted for.

Plan and show how to teach an identified topic in chemistry using ICT. Include your lesson plan and assessment scheme, and your lesson evaluation. Evaluate this activity.

### **Assessment criteria: Answer key**

You will need to work out yourself what your role will be when you are using ICT in your classroom. However, you will still need to take a leading role in the classroom. Just because you are integrating ICT into chemistry teaching doesn't necessarily mean that your normal role in the classroom will change. When considering your role in your lesson plan or scheme of work you will need to ask:

- What will your role be?
  1. participating or observing
  2. teaching a new skill (to a small group or the whole class)
  3. introducing a new topic
  4. stimulating and leading class discussion
  5. supporting ongoing work
  6. facilitating and mediating
  7. explaining new ICT vocabulary
- How much teacher direction will there be?
  1. What and how much teacher support is needed for this planned task?
  2. Will you share the intended learning outcomes with the pupils to help them engage in self-assessment?
  3. What kind of questions will you ask?
    4. closed questions that answer a simple enquiry?
    5. open questions that encourage pupils to take their learning forward?
  6. How much autonomy or independent thought will you be giving the pupils?

7. Will the pupils need to develop this skill or are they used to taking responsibility for their work?
8. How will you handle special needs like under resourced large classes?
9. Will you share your plans and strategies?

No matter what role you adopt, a good teacher will be constantly reading the situation and modifying, extending or changing strategies and roles in response to the needs of the class, group or individual pupil.

## XI. References

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- Chemistry @Davidson. Chemistry Experiments and Exercises <http://www.chm.davidson.edu/ChemistryApplets/index.html>
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- UNESCO (2002) Information and Communication Technology in Education A Curriculum for Schools and Programme of Teacher Development.
- Vega-Catalan. FJ.(1987) Problem solving in computer assisted instruction. In Computer aided instruction in Science and Technology. Proceedings of a Subregional Workshop in Lagos, Nigeria (ed A. Maduemezia). ICSU-COSTED pp43-48

## XII. Student Records

Name of the EXCEL file : Student performance record

|   | Module      |      |                 |            |            |                 |               |           |            |           |
|---|-------------|------|-----------------|------------|------------|-----------------|---------------|-----------|------------|-----------|
|   |             |      |                 |            |            |                 | 50%           | 50%       | 100%       | Pass/Fail |
|   | Student no. | Name | Semester Test 1 | Assignment | Assignment | Semester Test 2 | Semester Mark | Exam mark | Final Mark |           |
| 1 |             |      |                 |            |            |                 |               |           |            |           |
| 2 |             |      |                 |            |            |                 |               |           |            |           |
| 3 |             |      |                 |            |            |                 |               |           |            |           |
| 4 |             |      |                 |            |            |                 |               |           |            |           |

The final assessment mark for the module is calculated by equal contributions of 50% from the semester mark and 50% from the final examination score. The two semester tests and the assignments (continuous assessment) go to make up the Semester mark. For those assignments completed as a group assignment, each member of the group is required to submit an individual write-up of the work undertaken. The submitted work should include the names and student numbers of the rest of the group.

A final mark of 50% or more is a pass. A mark of 39% or less denotes a fail. A final mark of 75% or more is a pass with distinction. An examination mark of 40-49% means that the student is required to write a supplementary examination. A minimum mark of 50% is necessary to pass. The highest final percentage mark a student can obtain in a supplementary examination is 50%.

### **XIII. Main Author of the Module**

Prof Gilbert Okeanonife Onwu is the main author of this module. He is a chemical educator with a background in chemistry and science education. He received his B.Sc. and PGCE from Goldsmiths College, University of London and M.Sc and Ph.D degrees in chemical education from the School of Chemical Sciences University of East Anglia UK. He is Professor Emeritus in the Faculty of Education, Department of Science Mathematics and Technology Education, University of Pretoria South Africa and an Independent Consultant in Research to a number of higher education institutions and local and international organisations. He is an elected member of the Academy of Science of South Africa

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#### **Author of Conceptual framework:**

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Dr. Salomon TCHAMENI NGAMO holds a Masters in Educational Administration and a PhD in Education from the University of Montreal in Canada. He specializes in pedagogical integration of ICT and distance learning. Research professional, trainer and consultant in the Interuniversity Research Centre on training and the teaching profession (CRIFPE) and Canada Research Chair on the integration of information and communications technology (ICT) of the Université de Montréal, he accompanies and provides technological support to Université de Montreal distance learning students of Master and PhD. Besides his research interests focus on the pedagogical integration of ICT, he is a regular member of the research team on the knowledge transfer (TC) and skills development process of the Université de Montréal (<http://www.equiperenard.ca/membres/salomon-tchameni-ngamo/>).

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