Chemistry

ICT Integration in Chemistry

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NOTICE

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I. ICT Integration In Chemistry

By prof. Gilbert Oke Onwu and Dr Salomon Tchameni Ngamo

II. Prerequisite

ICT basic Skills
Access to a computer
Access to Internet* (highly recommended for many activities)

III. Time

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

IV. 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 multi-media display boards
- Word-processing facilities

V. 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.
VI. Content

6.1 Overview

Though Web-based technologies are considered to be widely used for educational purposes, the process of integrating ICT in education is hardly 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. ICT is 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, and in particular for offering higher quality distance education programmes to Chemistry students. An introduction to the theories and principles of ICT integration is presented within the identified themes, and further developed into seven specific learning objectives of ICT application, which can be adapted according to the specific subject area.

6.2 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. Thus, the process of integrating ICT in subject specific areas is of necessity incremental and relies on 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:

1. Pedagogical principles and theories of ICT integration in Education:
   ICT in Education Projects and Themes (20hrs)
2. ICT for Chemistry Teaching and Teacher Professional Development:
   Chemistry specific learning activities (100hrs)

The module content provides a teacher training curriculum that incorporates the pedagogy, i.e. specific learning objectives and learning activities required to effectively integrate ICT into Chemistry education.

SECTION I: Conceptual framework

1.1 Required course materials
1.2 Module Rationale
1.3 General objectives, Specific objectives
1.4 Learning activities
   1.4.1 Pre-assessment
   1.4.2 Key concepts
   1.4.3 Required readings
   1.4.4 Multimedia resources
   1.4.5 Useful links

SECTION II: ICT integration in specific disciplines

2.1 Crosscutting learning activities
   2.1.1 Report on required readings + evaluation
   2.1.2 Report on selected readings + evaluation
2.2 Discipline-specific learning activities
   2.2.1 Activity one + evaluation
   2.2.2 Activity two + evaluation
   2.2.3 Activity three + evaluation
2.3 Module synthesis
2.4 Final evaluation
2.5 References
Pedagogical integration of ICT in Chemistry

Part one

Conceptual framework

- Required course materials
- General objectives
- Specific objectives
- Learning activities
  - Pre-assessment
  - Key concepts
  - Required readings
  - Multimedia resources
  - Useful links

Part two

ICT integration in disciplines

- Crosscutting learning activities
  - Report on required readings + evaluation
  - Report on selected readings + evaluation
- Discipline-specific learning activities
  - Activity one + evaluation
  - Activity two + evaluation
  - Activity three + evaluation
  - Activity four + evaluation

Part three

Module synthesis

Final evaluation

Biography of the module author

References
VII. General Objective(s)

The module’s general objective is to help 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 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.

VIII. 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:

1. Critically apply the pedagogical principles of ICT integration in education.
2. Develop and facilitate ICT-based learning activities in the context of teaching chemistry.
3. Analyse and evaluate appropriate content and context for the use of ICT in chemistry teaching.
4. Use appropriate and varied communication and multimedia tools (emails, websites etc) in teaching and learning chemistry.
5. Use ICT efficiently in research, problem solving and project-based learning in chemistry.
6. Use ICT efficiently for professional development in the context of teaching and learning chemistry.
7. Integrate ICT appropriately into chemistry curriculum activities that will foster students ownership of their ICT-rich learning environment.
IX. Teaching And Learning Activities

9.1 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 strongly suggested 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.

9.2 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

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<th>Areas of Competence</th>
<th>Level of confidence</th>
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### 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

6. Using virtual labs and simulations (e.g. Optics Bench Applet http://www.hazelwood.k12.mo.us/~grichert/optics/intro.html, Physics 2000), (e.g. Chemistry http://www.chm.davidson.edu/Chemistry/Applets/index.html, Using on line chemistry courses (e.g. Distance learning Technologies

7. Using chemistry modelling software (e.g. Crocodile clips). See http://www.crocodile-clips.com/science/

8. Use of other ICT resources (e.g. Junior Insight & Sensing/sensor equipment, digital camera, E-microscopes).

Active Primary for whole class teaching
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<tr>
<th>Low</th>
<th>Need Help</th>
<th>Good</th>
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<th>Very High</th>
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<td>2</td>
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<td>4</td>
<td>5</td>
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**D) Using ICT in Science**

9. Using generic software to present information and for creating pupil resources in (e.g. TWAW, 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. TWAW, 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 e.g. to create and adapt teaching resources, write reports, plan out timetables, record pupil data.

13. Use the Internet for professional development (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)
9.3 Precautions about misconceptions in e teaching and learning

Learners

This section offers support to students who are apprehensive about working with computers or using the Internet. You will also find in the section a number of useful tips that would help you to avoid some of the more common pitfalls, misconceptions and prejudices. For you to appreciate the relevance and appropriate application of ICT, you need to take a critical look at the perceived and real risks if any, of teaching with ICT.

Misconceptions about ICT sometimes arise as a result of misunderstandings or insufficient knowledge one has about how things work. The preconceptions held might be close to the correct view but are essentially incorrect.

For example, children may have a naïve view of how the computer works, crediting it with super intelligence beyond the capabilities of any existing machine. Such views may have been developed as a result of some of the more mind boggling things information technology has been able to achieve in modern times. Hence, young people’s alternative frameworks often involve perceptions and/or limited understanding of the nature of technology. But 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.

However, not all teachers are convinced that ICT should be an integral part of their teaching strategies (Galanouli, Murphy, & Gardner, 2004). Resisting change is a state of mind for many teachers, and it is one of the most difficult barriers to effective ICT 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. Issues such as the role of ICT in a changing society could be framed for discussion in a way that provides for informed opinion. The assertion for example that: “The Internet is potentially dangerous and people just want to sell you anything imaginable without any moral compunction”; “Computers are ‘boys toys’ and not interesting or useful to girls” are certainly interesting statements that need to be justified or debunked.

Similar topics can be proposed for elucidation, even your own perceptions and attitude towards the use of ICT in schools.
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 pupils need more direction than that. If you want pupils 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 an accord with the language of instruction.
  - You may need to identify a short list of key words and concepts to be explained to pupils 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.
- **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:

  o 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;
  
  o ‘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.
X. 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.

ICT: Information (I) and Communication (C) Technologies (T) - the term ICT encompasses innovative audiovisual, 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.

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. Among other definitions, this concept implies a process of appropriate, regular, and regulated use of interactive technology with incurred beneficial changes in school practices and student learning.

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.

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.
**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.

**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.

**Non-synchronised communication**: E-learning offers the option to de-synchronise educator and learner time, allowing them to communicate based on their own schedules, through multimedia information exchange networks – for example using email or e-platforms to submit work.

**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, 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.

**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.

**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.

**Datalogging**: 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 datalogging 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. From a teaching perspective, the use of computer-assisted datalogging in chemistry involves a shift of emphasis from routine gathering of data to more interpretative student activity.
XI. 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.

Compulsory reading #1


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


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


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


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**


**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**


**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 with examples and are adaptable to the different learning areas 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

**Tuvin-Arad I; & Gorsky P. (2007).** *New Visualisation tools for learning molecular symmetry a preliminary evaluation*

Dept of Natural Sciences, The Open University of Israel, Israel.

Published online: Journal of Chemistry Education Research and Practice, 2007, 8 (1) 61-72

**Abstract:** This research article is about molecular visualisation in chemistry learning using new IT visualisation tools. It describes how a website that helps students visualise and locate symmetry elements on three-dimensional (3D) molecular structure was developed. The article includes textual explanations and a tool kit -an open tool-that enables students to draw symmetry elements for any molecule in 3D. The paper focuses on how students learned while using the symmetry tool. The study provides empirical support for the use of visualisation tools in molecular symmetry and other areas of chemistry such as inorganic spectroscopy, quantum chemistry grounded in visualisation.

**Rationale:** Visual-spatial thinking, such as in molecular visualisation, is playing a central role in science education in general and chemistry education in particular. One of the contributions of this research to ICT-chemistry integration is that it confirms recent research findings of a positive correlation between student’s visual-spatial abilities and their achievements in chemistry learning and problem solving. The article provides good textual material on the 3D visualisation tools that have been used to enhance student’s understanding of molecular symmetry.
The tool can be used at various content levels, for testing and for diverse audiences. Molecular symmetry is taught in several chemistry courses, e.g. inorganic spectroscopy, each with its own context and varying conceptual levels. It is therefore useful and appropriate for you the student to be familiar with both the study design and implementation of such an approach to chemistry teaching and learning, that makes use of the Web for visualisation and information inquiry.

Compulsory Reading # 9

Dept. of Chemistry Education, Faculty of Chemistry, Adam Mickiewicz University Poland.
Published. Journal of Chemical Education Research and Practice 2006, 7, (1) 1-12

Abstract: The article outlines the process of ICT integration in traditional chemistry laboratory teaching. It describes the development of a computer based programme for testing the effectiveness of using interactive laboratory instructions in chemistry teaching. Overall the study shows that the use of interactive laboratory instruction increases performance in the resulting laboratory skills and shortens time spent on completing laboratory exercises and tasks. A number of transition steps were found to characterise the integration of ICT- laboratory learning environments.

Rationale: The paper contains useful information on how to go about the integration of ICT in chemistry laboratory teaching using multimedia interactive instruction. Although ICT has been integrated in many chemistry courses and has shown educational benefits, changing teachers’ traditional teaching is still a challenging process. The study addresses teachers’ positive and negative perceptions of ICT enhanced learning environment 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 use interactive instruction instead of paper instruction.

Compulsory Reading # 10

T@lent ICT Training for Teachers

Abstract: This is an online teacher training programme from the United Kingdom on integrating ICT into the primary and secondary classroom. When looked into
in terms of its curriculum, the training modules provide good models either in
delivery mode or in a more integrated ICT-pedagogy approach. The website:
http://ecs.lewisham.gov.uk/talent/help.html will provide further information on
ICT training for teachers. As unfortunate, funds for funding the Talent site have
come to an end, and with it the maintenance of the site. In consequence, some of
the various links and resources may be increasingly out of date, but the pedago-
gical ideas are still valid and extremely useful to the teacher for ICT-Chemistry
integration.

Rationale: The Lewisham website and the booklet found in module 3, contain
very useful resource on planning and assessing ICT integration in chemistry edu-
cation. Lesson planning formats and assessment guidelines for ICT integration in
science are available online, so that they can be used as templates for improving
or creating one’s own ICT-based lesson plan; or preparing a unit lesson plan
template, portfolio rubric and sample unit portfolios of chemistry lessons. You
should aim to complete modules 1, 2 and 3, adapting them to your own peculiar
circumstances. Making use of them also helps to build your confidence and
competence in accessing relevant information from the Internet. Other teaching
and learning resources are also available for downloading in Word Format from
the resources page. (http://ecs.lewisham.gov.uk/talent/pricor/resources.html#Pl
anningandAssessment) For example

- Using a spreadsheet and Planning sheet
- Simulation

Compulsory Reading # 11

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 com-
prehensive 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 # 12

UNESCO Bangkok (2003) Teacher Training on ICT Use in Education in Asia and the Pacific: Overview from selected countries. 52p.

By Information Programmes and Services. Bangkok: UNESCO Bangkok

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.
XII. Multimedia Resources

Learners

In this section, you will find **multimedia resources** 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 **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. Education research shows that this will help learners be more prepared and help them articulate previous knowledge.

XIII. Useful Links

Learners

In this section, you will find **links** you will find 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 **links** 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.
Useful links # 1

Big Brown Envelope Educational ICT Resources

http://www.bigbrownenvelope.co.uk/

Description

This site Web provides access to the very educational resources for teachers to aid use of ICT in their lessons.

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 enticing.
Useful links # 2

Educ - Portfolio
www.eduportfolio.org

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 # 3

ICT resources and guidance for teachers at all Key Stages
http://www.teachernet.gov.uk/teachingandlearning/subjects/ict/
Description

Practical help on using ICT in teaching is provided by TeacherNet.

Rationale

The application of technology in distance learning presupposes the availability of well-developed and reviewed content. TeacherNet, to this end, assists educators in the complex and fascinating challenges of integrating technology with their teaching methods, by providing tools and pedagogical content.

Useful Links # 4

UneSco Bangkok : ICT Resources for Teachers CD-ROM

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

Description

ICT Resources For Teachers CD-ROM contains a set of ICT-based resources for teaching and learning of science, mathematics, etc. 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 relevant to subjects. A separate directory is provided to give an overall view of the types of resources available.

Rationale

In pedagogy the use of a variety of available resources stimulates learning. Appropriate audio-video support for learning activities which include diverse, information-rich, content, seems to hold learner’s attention throughout the training process. Additionally, learning activities appear less monotone. This UNESCO website is worth a visit because it provides a collection of these resources for learning math and the sciences.
Useful links # 5

4Teachers : Home Page

http://www.4teachers.org/

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. Discover valuable professional development resources addressing issues such as equity, ELL, technology planning, and at-risk or special-needs students. Here you will find some of our 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. As well, when these resources reflect real experiences of technology integration, they allow educators to discover new ideas and enhance their professional development.
Useful link # 6

Education World: The Educators Best Friend

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

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 # 7

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 # 8

http://www.unescobkk.org/index.php?id=1366

Description

This website includes a number of free, downloadable resources and provides substantial support for childhood education. Also available is free software for educators.

Rationale

Games play an important role in children’s lives. They contribute, in large part, to motor and cognitive functions as well as accelerating the process of gaining social skills and knowledge. This UNESCO website is an easy-access source for a variety of interactive learning activities which supports different aspects of childhood development.
Useful links # 9

Unesco-Bangkok : ICT in Education
http://www.unescobkk.org/index.php?id=1366

Description

Five principal themes related to ICT integration policy are available on this UNESCO website. Teacher training, teaching, learning and monitoring are explored.

Rationale

Teacher training is only one, but perhaps the foremost, among the multiple preconditions necessary for the successful integration of ICT in education. In addition to reviewing information related to learning and teaching, this website also provides useful information on ICT integration policy.
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 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 to the need for quick movement or transfer across the three identified levels of chemistry understanding-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 # 11

http://ecs.lewisham.gov.uk/talent/secsci/TaLENT_SCO.htm

Description

Information and Communications Technology (ICT) is widely recognised as a valuable tool for enhancing teaching and learning. This website provides a comprehensive ICT training programme for pre and in-service teachers including science/chemistry teachers. The curriculum adopts a modular approach in which the modules are arranged and presented in a sequential and logical fashion. The T@lent website map (above) shows the structure of the site. Funding of the site has since come to an end. It is likely that the various links and resources will be increasingly out of date, but the pedagogical ideas of ICT integration are still valid and useful. You need to keep this in mind. If you do find anything which is seriously wrong, broken links or lack of accessibility please send an email to the editor webmaster@talent.org.uk who will endeavour to put things right.

Rationale

This website offers a wealth of resources for ICT-related teaching and learning of science/chemistry. Its availability and accessibility increases the opportunity and the need for you to be confident and competent in using ICT effectively in your chemistry teaching. In accord with the aims of the programme, the training modules set out to provide users with the knowledge and understanding of ICT to
support effective teaching; give users the opportunities for understanding the role of ICT in subject teaching; and thirdly, enable users to integrate ICT appropriately into curriculum activities that will meet all students’ needs and abilities.

Useful links # 12


Description

This site features a state-of-the-art technology for a fully interactive chemistry learning experience. The ThinkQuest library boasts of a number of chemistry textbooks on line for undergraduate studies, a list of chemistry education-related topics that are designed for student interactive hands-on experience. It is a website designed by and for chemistry students themselves.

Rationale

An interactive, hands on experience is one way of learning that is effective and great fun. This website provides a veritable source of information of useful topic sites, for chemistry teaching and learning in an IT-rich environment. It provides among others an exhaustive guide to chemistry on the Internet, which include chemistry textbooks online, Chem Web online, Digital Chemistry textbook etc.. For example, Chem Web 2000, whether for a beginner or an advanced chemistry student, is an excellent site for studying and understanding various topics in chemistry in an interactive manner.
Useful links #13

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.
Useful links #14

http://lapeer.org/ChemCom/Index.html
http://chem.lapeer.org

Description

This web site is for science/chemistry 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 much more information available, it is just a matter of finding what is relevant to your needs.
Useful links # 15

http://www.chm.davidson.edu/resources.html

Description
This website is a collection of chemistry applets simulating various chemical systems and experimental systems. It exposes the user to virtual chemistry experiments and exercises. These configurable applets are available for use, and to create new web pages containing customized simulations and representations of chemical experiments.

Rationale
The chemistry-specific learning activities of this module require of the student knowledge of subject matter content (i.e. chemistry), and a measure of competence in chemistry-ICT integration skills. This web site provides the user/student with the invaluable opportunity to review a variety of resource based ICT-chemistry integration activities, for possible adaptation in a given classroom situation. This collection of applets includes a series of tutorials and simulated experiments available for a variety of chemistry topics; 3D visualisation of molecular structure, and generated computational chemistry exercises.
XIV. Learning Activities

Learning activity # 1 (Crosscutting activities for all modules)

Title of Learning Activity: Written report on compulsory reading

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

Summary of learning activity


Reference for the compulsory reading:

- UNESCO (2004). Technologies de l’information et de la communication en Education : Un programme d’enseignement et un cadre pour la formation continue des enseignants. Division de l’enseignement supérieur. ED/HED/TED/1

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 pe-
dagogical 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 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.

**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.


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 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

Summary of the learning activity
Various positive impacts of ICT use in mathematiques 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%)
Learning activity # 2 (crosscutting activity for all disciplines)

Title of the learning activity : Report on reading of your choice.

Detailed 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). 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 resumé of the two texts (40%)
- The critical analysis of the readings (20%)
- Presentation of the material, within the defined parameters the assignment (20%)

Learning Activity # 3.1 (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

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

- Are there useful support materials which come with the package, consistent with the learning outcomes of the lesson?
- Is the language and information suitable for the special needs of the pupils you are teaching or hope to teach?
- Is it relevant to your scheme of work?
- What links are offered to other sites? (web sites only)

Teaching and Learning

- How long will it retain pupils’ attention, interest and motivation?
- Does it support active learner participation and development of higher order thinking and problem solving skills?
- Will it support the learning of less academically motivated pupils?
- Can it extend the learning of highly able pupils?
- Will it support and enhance teaching? In what way?
- Will it support and enhance learning? In what way?

This website [http://ecs.lewisham.gov.uk/talent/conference.htm](http://ecs.lewisham.gov.uk/talent/conference.htm) for secondary science includes 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 it.

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. (e.g. Rates of Reaction)

Detailed description of the activity:

Begin by reading the 3 manualsL1. The UNESCO publication entitled “Information and Communication Technology in Education : A Curriculum for Schools and Programme of Teacher Development (2002)”. The manual provides a practical and realistic approach to teacher development in the context of ICT integration at secondary school level.

The booklet “Ideas for integrating ICT into the primary and secondary classroom” (published by Lewisham Education and Community Services) contains useful information on planning and assessing ICT in the introductory sections. The worksheets used in the book are available online from the links below so that they can be used as templates for producing your own documents. They are also available for downloading in Word Format from the ICT resources page.

- Using a spreadsheet

See also Datalogging IT activities for science 11-14 Oxford; Heinemann, p1,2)

- Simulation
**Introduction**

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.

**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

Using a spreadsheet to explore relationships in experimental data

Year Group:

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

Students provide simple explanations why chemical reactions proceed at different rates.

They describe some methods of monitoring rates of reactions and the parameters involved in such investigations.

They determine the factors affecting the rates of chemical reactions.

Chemistry learning outcomes related to task:

They make appropriate choices when using ICT-based models or simulations to help them solve a problem.

They use ICT-based models and simulations to explore patterns and relationships, and make predictions.

They explore the effects of changing the variables in an ICT-based model.

ICT learning outcomes related to task:

Teaching Approach

Undertake a pre-activity discussion in which the whole class is reminded about spreadsheets and graphing. Students work in groups collecting experimental data
then individually or still 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 Observation
- Peer/Self Assessment
- Teacher/Student 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:**

- the identification of the topics in chemistry suitable for the use of spreadsheets (20 marks)
- the process of designing the spreadsheet (50 marks): headings of columns and rows
- the varying width of columns
- the allocation of values and units of measurement to columns
- the creation and copying of formulas
- the rearranging of entries (rows) and columns
- the import of information from a variety of sources
- the export of information to a variety of destinations
- 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.

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

http://www.dlt.ncssm.edu/TIGER/chem3.htm 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:

(i) ICT sources of information, CD-ROM encyclopaedia (e.g. encarta.msn.co.uk, http://www.eb.com),
(ii) Collecting and analysing data (databases such as Appleworks database, Microsoft Access or Information Finder and spreadsheets such as Microsoft Excel and Appleworks spreadsheet)
(iii) Modelling (spreadsheets such as Microsoft Excel and Appleworks spreadsheet)
(iv) Communicating (Internet electronic mail and the world wide web)

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

**ICT INTEGRATION**
Using a simulation to explore relationships in experimental data

Year Group:

Resources
Simulation software

Context

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

Content

Students, working in pairs or individually use a simulation and record data from an experiment in which the volume of oxygen in sodium hydrogen carbonate 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.

Learning Intention

Science Knowledge and Understanding
ICT Skills, Knowledge and Understanding

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.

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.

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.

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 Observation
- Peer/Self Assessment
- Teacher/Student Discussion

### Assignment and Assessment

This is a decision-making exercise in which decisions have to be made on chemical, 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
- Handle/Use chemical literature efficiently and critically
- Argue logically and precisely, both in oral and written form
- Make decisions that you can defend, often on inadequate information

### Project

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

**Decision 1** What can it be exploited for in chemical terms? Argument leads to suggestions of NaOH, Na₂CO₃, Cl₂ 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 demand trend figures, how big should the factory be and what will it cost?

Decision 3. If we take one commodity (\( \text{Na}_2\text{CO}_3 \)) how much will it cost to make it by the processes suggested in terms of raw materials, wages of labourers etc?

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

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

This exercise gives you experience in argument, in weighing up variables, 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 databases to find relationships and commonalities, in terms of say structure and the corresponding properties and function.

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

- Periodic table
- Genetic Variation (modelling)

A different approach to building up ICT skills within the science curriculum is to familiarise oneself with the STEM Project. The project encourages pupils and teachers to write web pages providing educational content about the science museum which others can then use by accessing them on the Internet. Further information and an index of current entries can be found on the STEM website. A free resource pack has been produced that includes help on writing web pages, a project planner 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.

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 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.

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 allows a higher order thinking.

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

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 different parts of a measurement system can be introduced. Students can work with the collected data using measurement software to create diagrams, graphs, perform calculations and draw conclusions. At a later stage they can perform the computerized measurement themselves.

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.
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 & Doyi 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 tools—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.

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 privat 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.
Learning Activity # 5 (ICT in Chemistry)

Title of the learning activity: 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 I: *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
斩获 information from reasoning
■ solution:

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

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 m/s² 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)= 1kg x 9.8 m/s² = 9.8N

The corresponding network is shown below:

◊ data given is mass = 1kg
○ information from memory: weight = force
○ information from memory: force= mass x acceleration
○ information from memory acceleration of gravity = 9.8m/s²

Networks are very useful since they break down problems into pieces of infor-
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:**

- What do you want to assess?
- How will you assess?
- How will you collect evidence?
- How will you record achievement?
XV. Synthesis of the Module

Summary of the principles and theories of pedagogical ICT integration

The scientific literature contains a broad range of statements on the principles and theories of ICT integration into instructional practices. This module identifies 28 key principles regrouped into 5 main orientations, each comprising a set of professional competencies to be developed in a teaching/learning context. Accordingly, teachers must be able to:

Exercise critical judgment and sensitivity regarding the real benefits and limitations of ICT as teaching and learning resources.

This first orientation includes 5 key principles:
- Vigilance and careful assessment of the impacts of ICT on their students and on their own work
- Alertness to social inequality or exclusion resulting from inability to access resources
- The principle that ICT are not of themselves generators of innovative educational change
- The principle that ICT serve the behaviorist, cognitive, constructive, and instructive approaches equally well
- The principle that ICT should facilitate learning integration and transfer, make learning more meaningful, and help students develop their talents, imagination, resourcefulness, creativity, and the like.

Identify and assess the potential of computer software and networking technologies to develop targeted educational competencies.

The 5 key principles stemming from the second orientation are:
- Exploring a number of educational sites to identify appropriate resources in the teacher’s subject area or teaching field
- Maintaining an activity bank to help students with their learning and to support other educational practices
- Assessing resources not designed for instructional purposes and adapting them for the competencies targeted in the study program. Evaluating tools and selecting those that best develop the intellectual and relational competencies targeted. An assessment of the potential of computer software and networking technologies to develop targeted competencies would appear to be critical for achieving educational targets, seeing that many commonly used resources (grammar checkers, Web sites, audiotapes and videotapes,
CD-ROMs, etc.) have not been specifically designed for educational purposes.
- Determining instructional needs and equipment requirements and eliminating items that are attractive but of little educational value.
- A thorough analysis of educational software to evaluate the content breakdown, presentation of learning and/or problem-solving steps, tracking reportage, and data handling.

**Identify and communicate with a variety of appropriate multimedia resources (e.g., email), collaborative tools to which ICT can make a significant contribution.**

Using ICT effectively, teachers can build networks for information sharing and professional development in their teaching fields and practices, bringing together the work and reflections of individuals with similar interests but from disparate locations. This orientation includes 9 pedagogical principles of effective communication that generate a “collective intelligence”:

- Collaboration, teamwork, joint action, and utilization of the collective intelligence of individuals located at a distance
- The use of thematic, research, peer email, discussion group, databank, image, and sound networks.
- Selection of interactive resources and audiences for specific objectives
- The necessity of establishing selection criteria for professional development resources
- The use of collaborative peer networks to help train new graduates as well as colleagues
- Building networks of teachers who share the same expertise
- Guiding student-directed interactive learning
- Helping students target, formulate, and refine their questions so that ICT information searches are relevant, meaningful and suitable.
- Careful precision in terms of the quality of language used.

**Use ICT effectively to search for, interpret, and communicate information and to solve problems**

To better integrate learning resources, the information obtained must be converted into secondary culture (i.e. schooling) objects through the development of knowledge transfer competencies. The use of ICT therefore imposes new demands on teachers’ ways of working: how they structure collective teaching, teamwork, individual work in the classroom, and homework. In this perspective, teachers must adopt 4 essential principles to help students use ICT productively for research and problem solving:
- Targeting of information, and critical analysis and conversion or transformation of useful resources into learning objects for educational activities
- Tracking of students’ progress and interrupting their work as needed
- Raising awareness of Internet navigation and providing guidance, e.g., pointing out pitfalls
- Getting students back on track through suggestions, questions, and tips to help students develop critical search strategies.

Help students familiarize themselves with ICT and use it to carry out learning activities, assess their own use of ICT, and exercise critical judgment toward the information they find on the Internet.

Teachers must also have certain competencies and abilities in order to support student learning with ICT. Accordingly, 5 fundamental pedagogical principles must be applied:

- Developing basic and essential ICT competencies, with an emphasis on computer literacy: introduction to ICT functions and tools (familiarity with common software such as Word, Excel, PowerPoint, etc.) and basic operations (downloading, saving, and filing educational materials, compiling and organizing information).
- Choosing the appropriate tools for a given task, integrating a number of tools to solve actual problems, and using them on an everyday basis in a critical and productive way to serve as a model for the students.
- Using a diversity of ICT software to teach, learn, communicate, and solve problems in different subjects, and adopting clearly expressed, critical stance toward these technologies.
- Developing projects and the accompanying documentation (e.g., worksheets, digital portfolio) that integrate various aspects of the course content and extend the meaning of the information beyond the classroom.
- Evaluating the learning achieved through specific questions, effective work processes (e.g., integrated online self-evaluative learning, access to glossaries and extra class notes at Internet-accessible hypertext sites, etc.)

The following figure illustrates the main orientations of the key pedagogical principles of ICT integration.
First concept: Exercise a critical and perceptive mind regarding the advantages and limits of ICTs in teaching and learning.

Second concept: Assess the potential of ICTs and network tools in relation to skills acquisition in training programmes.

Third concept: Communicate with the help of various multimedia tools.

Fourth concept: Effectively use ICTs for research, interpreting and communicating information and for problem solving.

Fifth concept: Efficient use of ICTs in developing exchange networks and continued education in the specific field education and the teaching profession.

Sixth concept: Help students to take ownership of ICTs to use them for learning activities and assess the students’ use of ICTs as well as make a critical appraisal of data collected on the networks.

Illustration of Major concepts in the integration of ICTs in education
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 resources (an important skill in Open and distance learning). Examples of learning activities, which can be modified to suit specific disciplines, are provided, as are a number of useful links (illustrated with screen captures), the latter presenting pedagogical resources and serve to guide educators and learners in their knowledge-seeking and training processes. A bibliography is provided to further support techno-pedagogical skills, facilitate research, lesson planning, teaching, problem-solving, professional development, and most importantly to enhance student’s learning through ICT.

**Summary- specific in chemistry**

Information and communication technologies facilitate worldwide contacts between teachers and students. The Internet is now a veritable 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.
XVI. 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 by email or online to the instructor.

1. 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

   (i) 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?

   (ii) 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.

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

   (iv) 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.

   (v) 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?

   (vi) What range of ICT skills do you think all your pupils in the end will be able to demonstrate?

   (vii) How would you go about addressing any deficiencies
In your discussion you should take into account the diverse learning needs of all your pupils.

The use of ICT in science can enhance subject learning for all abilities, see the Inclusion section of the National Curriculum for science as a guide.

**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.

2. 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.
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?**

- participating or observing
- teaching a new skill (to a small group or the whole class)
- introducing a new topic
- stimulating and leading class discussion
- supporting ongoing work
- facilitating and mediating
- explaining new ICT vocabulary

**How much teacher direction will there be?**

- What and how much teacher support is needed for this planned task?
- Will you share the intended learning outcomes with the pupils to help them engage in self-assessment?

**What kind of questions will you ask?**

- closed questions that answer a simple enquiry?
- open questions that encourage pupils to take their learning forward?

**How much autonomy or independent thought will you be giving the pupils?**

- Will the pupils need to develop this skill or are they used to taking responsibility for their work?

**How will you handle special needs like under resourced large classes?**

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.
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ICT Training for Teachers http://ecs.lewisham.gov.uk/talent/conference.htm

XVIII. Student Records

Name of the EXCEL file: Student performance record

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%.
XIX. Main Author of the Module-ICT Integration in Chemistry

Gilbert Oke Onwu is the co-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 an M.Sc and a Ph.D in chemical education from the School of Chemical Sciences University of East Anglia UK. He is currently professor of chemical education, head of the department of science mathematics and technology education and Chair School of Teacher Training in the Faculty of Education, University of Pretoria South Africa. E-mail address gilbert.onwu@up.ac.za

Author of the Module - Conceptual framework

Salomon Tchameni Ngamo is the author of the introductory, conceptual framework, portion of this module. He studied Classics in his home country of Cameroon. In the four years since his MA in Education from Université de Montréal in Canada, he has developed expertise in the pedagogical integration of ICT. With a combined 15 years teaching experience in Africa, after winning an excellence prize during his own training, he is a department head at The National Institute of Youth and Sport in Cameroon, where he also instructs. In addition to his own research, he has co-authored course syllabi and research guides. As a research professional at the Canada Research Chair on Information and Communication Technology (ICT) in Education he coordinates joint Université de Montréal/ER-NWACA transnational research projects on ICT integration in Education in West and Central Africa.

Also an online teaching assistant, he is responsible for several cohorts of African students in the Université de Montréal/UNESCO/l’Agence Universitaire de la Francophonie distance learning micro-programs.

Most recently, Salomon Tchameni Ngamo’s expertise is being put into action in the development of Université de Montréal’s first distance education PhD offering, while he is also finishing his own PhD thesis in Pedagopsychology with a specialisation in Pedagotechnology.

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