

Utilising the Virtual Laboratory Resources for incorporating ICT in the Chemistry Teacher Education

Theme: Skill Education

Sub-theme: Chemistry-Teacher Education

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INTRODUCTION

Teaching chemistry laboratory procedures by means of a virtual laboratory on a personal computer will be much welcome by educational institutions for whom maintaining a hands-on chemistry lab is not viable due to various reasons. Instructional laboratory simulations can be incorporated in the virtual laboratory resources where students are free to make the decisions they would confront in an actual laboratory setting. Real-life situations and problems are faced by them, where they have to make/take decisions and face the consequences thereof. The student may take such additional support online after he has attended the same in the laboratory. Concepts and skills learnt by him through hands-on activity in the classroom-laboratory would be enhanced through this sort of blended learning approach. But the chemistry teachers are not often aware of the potential of these virtual laboratory resources. So an attempt to showcase the rich virtual laboratory resources are done in this paper so that the readers may be convinced that they must be utilised appropriately for incorporating "ICT in the Chemistry Teacher Education".

WHAT IS A VIRTUAL LAB?

The virtual laboratory should resemble the actual hands-on laboratory and thus has a lot of extra features and functions. Thus it serves as a very useful tool for teachers as well as for students. In a virtual laboratory, students deduce scientific principles by performing laboratory experiments. Experiments might be used to supplement experiments in student laboratories and enable the students to explore simulations of realistic physical situations. Although many of these simulations represent devices in an actual laboratory, often in many situations curious students are encouraged to build their own simulations using tools as simple as the electronic spreadsheet. Such models can be interrogated with a full complement of customizable graphical tools. The learners are also able to enter into extended dialogs with computer simulations and these sort of facilities of interrogation will provide students with a tool to clarify ideas. The virtual worktable, panels - for lab instruments and for substances respectively is the starting point. To perform a reaction the user just has to put the necessary containers on the worktable and put the needed substances in them. Simultaneously there may be link for seeing the animation of the same reaction even upto the molecular level. The program may also have periodic table, the solubility table, the oxidizing and relative activity table and even a glossary. Some of them may also include an equation editor, a scientific calculator and a unit converter. For summative evaluations and for incorporating more elements of active learning, self-tests, lab exercises/tasks and a lab log (in order to prepare reports of the experiments) may also be added to the above. The essential features of the virtual laboratory should thus constitute:

- a way to visually conduct experiments with different substances – visualisation of the invisible to the visible
- a model- and analysis-oriented view of the current reaction
- an "assistant" to simplify the work with the program
- valuable encyclopedic information regarding the elements
- a glossary

- self-test facilities
- interactive lab exercises
- a sophisticated unit converter
- a lab log
- a built-in calculator
- an equation editor
- a help file
- an attractive interface

EXISTING VIRTUAL LABS

A number of topics of chemistry practical (in the higher secondary level and undergraduate level) are already on the net for virtual lab in chemistry like:

- Qualitative Inorganic Analysis
- Organic Synthesis and Organic Qualitative Analysis
- Fundamental Experiments in Quantum Chemistry
- Gas Properties
- Titration Experiments
- Calorimetry

The available links to such websites are given below for the teachers to have an idea of such virtual laboratories.

1. <http://www.chem.ox.ac.uk/vrchemistry/>: The Oxford VR Group has developed a 3D simulated laboratory for the teaching of chemistry. The students can participate in experiments which are designed with the latest multimedia technology. A screen shot of one of the experiments is given below:

The screenshot shows a web browser window displaying the LiveChem website. The page has a blue header with the 'LiveChem' logo and an image of laboratory glassware. Below the header is a grid of metal ions and their oxidation states:

Sc	Ti +3	V +5	Cr +6 CHROMATE	Mn +2	Fe +2	Co +2	Ni +2	Cu +1	Zn +2
			Cr +6 DICHROMATE	Mn +7	Fe +3			Cu +2	

Below the grid is a text box with instructions:

Please click on a Salt from the top and a Reagent from the bottom and when the buttons have moved click on Play Movie.
Use the Reaction Info and Reagents Info buttons to find out more about each reaction.
Have fun and explore.

To the right of the instructions is a red-bordered box containing the text: "Database is currently being updated." Below this box is a button that says "Click to activate and use this control".

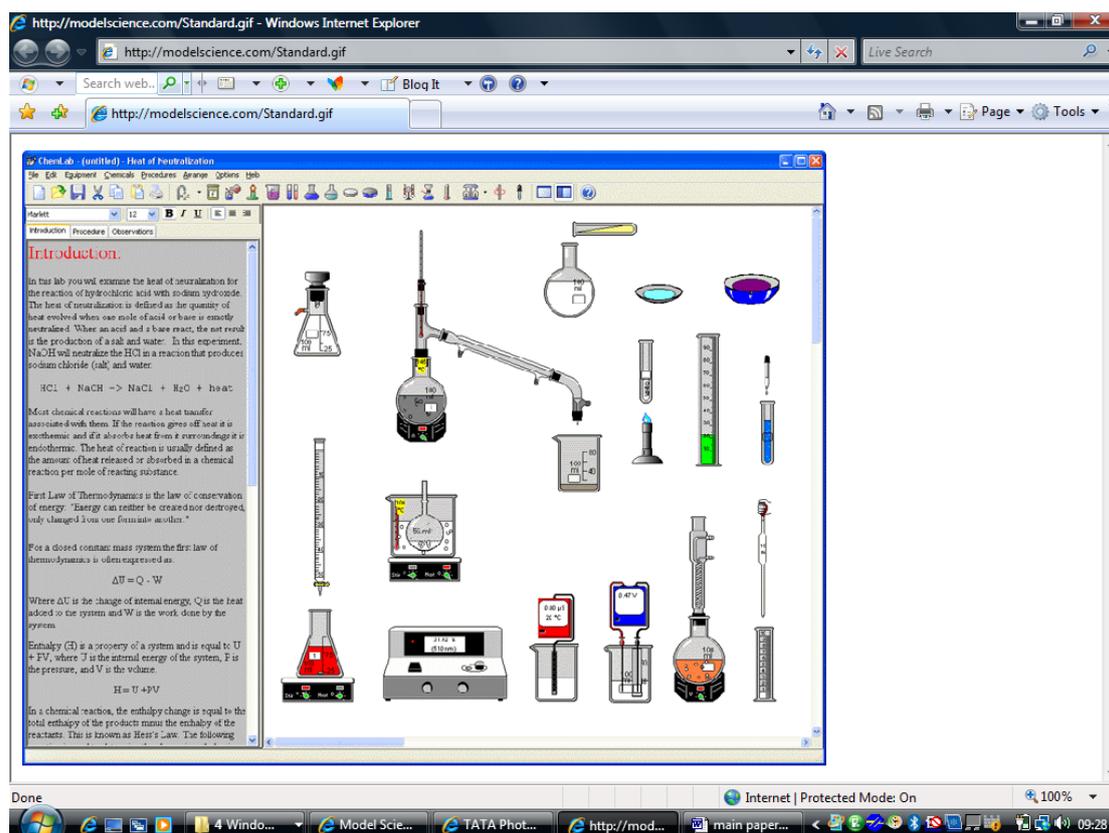
At the bottom of the page is another grid of reagents:

Sodium Hydroxide	Conc HCl	Dil HCl	Dil & CONC NH ₃	xsNH ₄ Cl & Dil NH ₃	Na ₂ EDTA & Dil NH ₃	Na ₂ SO ₃	KI	Alkaline NaOCl	KSCN	NH ₄ S _x
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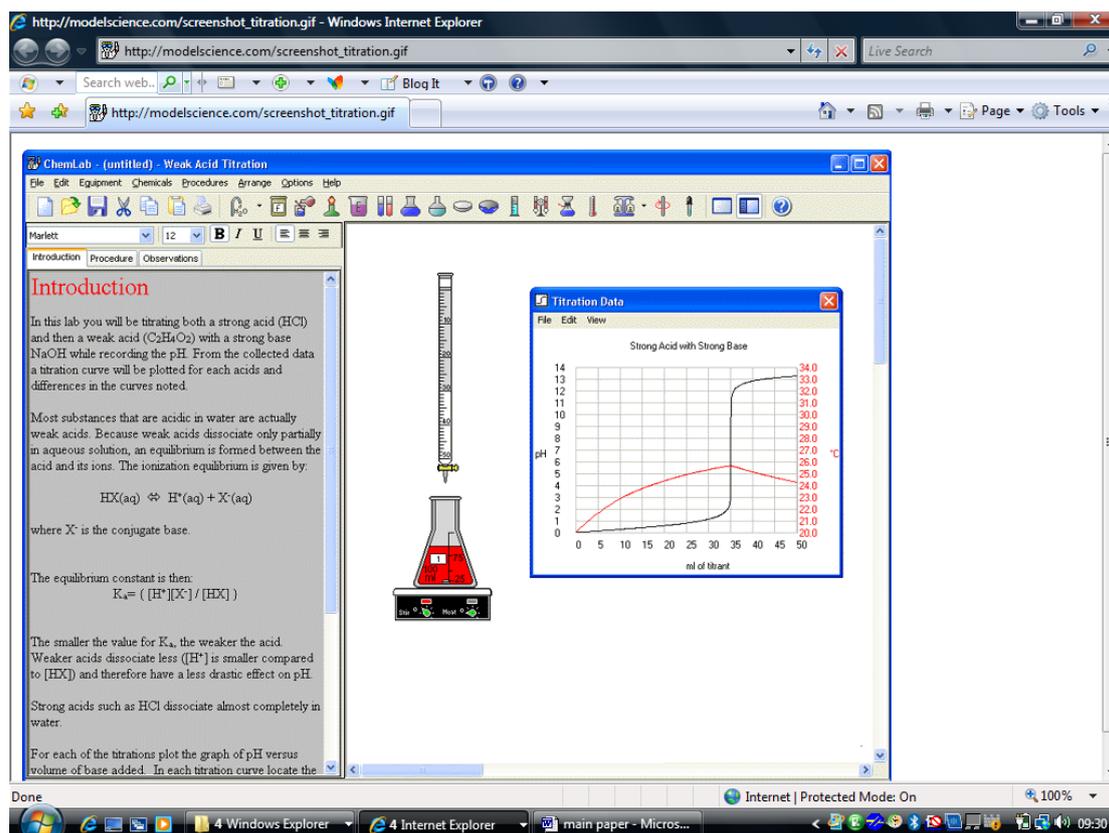
At the bottom of the page are buttons for "Play Movie", "Reset", "Reaction Info", and "Reagents Info". A progress bar is also visible.

2. <http://modelscience.com/>: The virtual lab "Model ChemLab" is very intuitive and easy to learn. It comes with over 20 different laboratory modules. Each module functions like a lab notebook with one page describing the principles and objectives, another page giving stepwise procedures, and a third page for recording observations and computations. The experiments are performed in a window by assembling components selected from a menu, and then interactively weighing, mixing, heating, measuring etc. It simulates laboratory experiments by providing lab procedures, apparatus and chemicals for students to run experiments. The ability to customise the existing activities and to include new ones using the Lab Wizard is a particularly attractive feature of this product. In addition, the software designers are easy to contact and open to ideas."

Screenshot of ChemLab standard is given below:

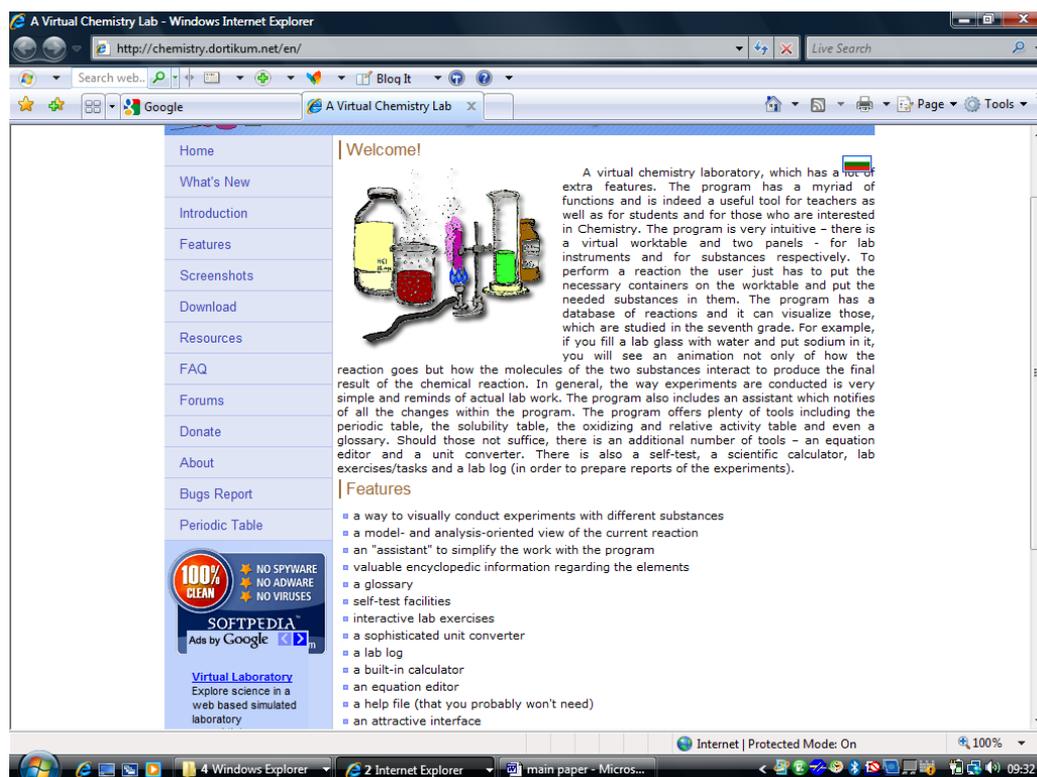


Screenshot of Titration curve is given below:

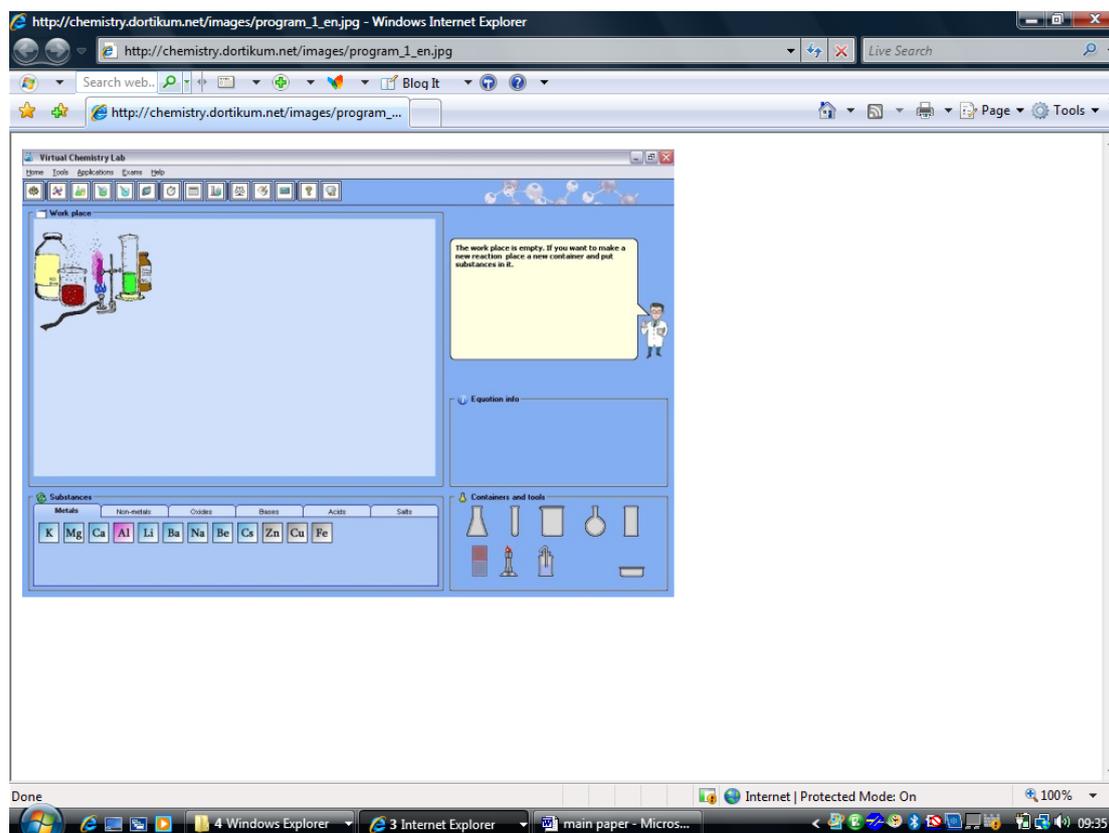


2. <http://chemistry.dortikum.net/en/>: Virlab. Virlab exercises can also be used as simple homework. Each exercise stands alone and may be performed in the order of any primary chemistry text. Virlab enables Visual laboratory experiences are provided using Actionsript and Flash. Students later build their own simulations using spreadsheets or symbolic math packages. Virlab can offer students the opportunity to explore science through discovery and experimentation. At first, lessons are tightly controlled and students are held firmly by the hand as they interrogate models, complete tables, and graph results. Later, students are guided into domains of genuine, independent, exploration. Chapters include stoichiometry, Molecular Weights and Moles, Equations of State, and so on.

Screenshot of the Virlab is given below:



Screenshots of the program is given below:



A Virtual Chemistry Lab - Windows Internet Explorer

http://chemistry.dortikum.net/images/apps_1_en.jpg

Equations

Barium + Iodine

Output substances: Products:

Check

Virtual Chemistry Lab

Valid xHTML • Valid CSS
Copyright © 2005-2010 chemistry.dortikum.net
Dortikum Development

http://chemistry.dortikum.net/images/apps_4_en.jpg

Solubility Table

Ions	Names	H ⁺	NH ₄ ⁺	K ⁺	Na ⁺	Ag ⁺	Ba ²⁺	Ca ²⁺	Mg ²⁺	Zn ²⁺	Cu ²⁺	Hg ²⁺	Pb ²⁺	Fe ²⁺	Fe ³⁺	Al ³⁺
OH ⁻	гидроксидни	P	P	P	P	-	P	M	H	H	H	H	H	H	H	H
NO ₃ ⁻	нитратни	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
S ²⁻	сулфидни	P	P	P	P	H	-	-	H	H	H	H	H	H	H	H
SO ₃ ²⁻	сулфитни	P	P	P	P	M	M	M	M	-	-	-	H	M	-	-
SO ₄ ²⁻	сулфатни	P	P	P	P	M	M	M	P	P	P	P	H	P	P	P
CO ₃ ²⁻	карбонатни	P	P	P	P	M	M	M	H	H	H	H	H	H	H	H
SiO ₃ ²⁻	силикатни	H	H	P	P	M	M	M	H	H	H	H	H	H	H	H
PO ₄ ³⁻	фосфатни	P	P	P	P	H	H	H	H	H	H	H	H	H	H	H
F ⁻	флуоридни	P	P	P	P	M	M	M	H	M	M	M	H	M	M	P
Cl ⁻	хлоридни	P	P	P	P	H	P	P	P	P	P	P	P	P	P	P
Br ⁻	бромидни	P	P	P	P	H	P	P	P	P	P	P	P	P	P	P
I ⁻	јодидни	P	P	P	P	H	P	P	P	P	P	P	H	H	P	P
CrO ₄ ²⁻	хроматни	P	P	P	P	H	H	M	P	P	P	H	H	H	P	M
CH ₃ COO ⁻	ацетатни	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P

Legend: P Soluble, M Less soluble, H Insoluble, - Breaking down, - Sediment

3. NetLab: Portal for students for University of Helsinki, Finland. To enable bridging between lectures, theory and practical lab this portal was developed with the help of web services. NetLab can provide students the detailed methods for practical work as well as interactive instructions on operating the instruments involved in the lab. 3D models of the products like in

a synthetic process are also available which takes care of the spatial contiguity principle. Animations are also present.

The following is screenshot of the LabNotebook in the virtual lab which has to be filled up by the students:

4. Network for education-chemistry: chemgapedia : www.chemgapedia.de - Network for education-chemistry – the Institute of Analytical chemistry of the Dresden University of Technology, Germany connected the ones who are interested in analytical chemistry. They have assembled of an web-based MLL (multimedia learning links) called Digital *PreLab*. Topics like chromatography, spectroscopy are dealt both theoretically as well as their treatment in frontier areas of applications are done. Constructivism, components of active learning are the main features of this virtual lab.
5. VMSLab-G(Riganelli, Gervasi, Lagana, and Frohlich, 2005): VMSLab-G- a true experience to real life chemistry lab. The portal for this is www.vmslab.org. A walkthrough experience is generated in the modules involved.
6. Open Learning Initiative Chemistry (OLI) is one of several introductory college courses developed by Carnegie Mellon University's Open Learning Initiative (<http://www.cmu.edu/oli/index.html>). The course offers a variety of learning experiences including video expositions, text, simulation activities in the Virtual Lab, and tutors to support the integration of declarative and procedural knowledge.

SUGGESTIONS FOR INCORPORATING ICT IN CHEMISTRY TEACHER EDUCATION:

Revamping “Chemistry Teacher Education” by incorporating ICT methods would surely enable the chemistry teacher-educators develop the 21st century skills. Incorporating the tools of the virtual laboratory in the teaching-learning situations would further enable the teachers

to deliver to the students laboratory techniques at a distance. Such ICT enabled learning through virtual laboratory resources would help the learners be involved in active learning. The teachers can also deliver their expertise in the subject-domain to learners at remote areas where due to economic or other constraints the hands-on laboratory is not viable. Already the MHRD has given the responsibility to the IITs to develop the virtual laboratories and IIT-Delhi has done much progress in that project. School and college chemistry teacher-educators should also be skilled to utilise at least the available virtual laboratories in the web to incorporate these tools in their lesson plans. Once the teachers are skilled and gain knowledge about these and pass on their know-how to their students, the students can actually utilise them and be involved in active-learning through distance learning methodologies. This would surely revamp the whole chemistry teaching-learning situation as a whole.

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