A Chemistry Dynamic Laboratory Manual for Schools

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An integrated, interactive e-learning tool designed to help students study for the practical components for Post 16 Chemistry has recently been launched. It is to be used in schools for pre-lab preparation and alongside laboratory sessions. It is also an engaging homework resource and an invaluable revision aid for key skills and experiments. The software integrates fully with a school's Virtual Learning Environments (VLEs). 'AS Chemistry LabSkills' builds on groundbreaking best practice developed in the undergraduate teaching laboratories at Bristol ChemLabS - the Centre for Excellence in Teaching and Learning in Practical Chemistry at the University of Bristol. This resource provides an opportunity for teachers to engage their students in practical science in a new and exciting way.

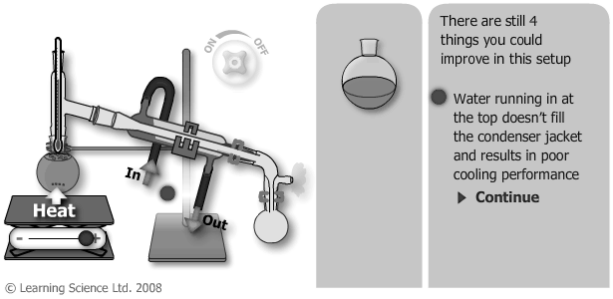

Figure 1 The simulation of the distillation process allows students to explore the correct set up

AS Chemistry LabSkills brings to schools and colleges the latest ideas in the use of e-learning to support the teaching of practical Chemistry. Students can prepare for practical classes by exploring the techniques and experiments that they will encounter in the laboratory itself. They can practice in a safe environment and receive directed and focused feedback on their performance. The virtual apparatus can be explored and in a digital sense undergo misuse as many times as required, whilst in the laboratory both time and cost of replacement of damaged apparatus could not be tolerated. Through this practice the students can understand why apparatus is assembled as it is and why instructions in practical work are as they are.

The material can be used in three main ways. The teacher sets a pre-lab exercise or homework, instructing their students which sections need to be worked through prior to the practical session. The teacher may also use the material in a revision capacity via a whiteboard. The students may also use the resource to revise their practical skills.

Traditionally students arrive at the lab to do an experiment without:

- a clear idea of the practical techniques involved,
- the skills needed,
- knowing the area of chemistry the practical demonstrates.

Typically it is only after the lab session during a write up that the students generally start to work out what it was they had been doing. Valuable lab time is spent with the teacher explaining how to set up the equipment at the start of the lesson and during the practical repeating instructions for students who did not listen effectively the first time. While students could look at the chemistry involved ahead of time in a text book, they cannot obtain easily practice in the use of equipment. Students will clearly receive much more from their limited laboratory sessions if they know what they are doing and pre-laboratory preparation is the key to achieving this. This has been shown in the undergraduate teaching laboratories at Bristol's School of Chemistry and in trials with Post 16 students in schools. The result is that students are more confident much better informed so can make better use of the teacher's time during practical by asking extended questions on the chemistry and not asking 'Where does this piece of glassware go?'.

There are some teachers of chemistry who make the excuse for not doing as much practical work

as they would wish on insufficient time. A clever piece of software called AS Chemistry LabSkills will help. The resource maximises the learning opportunities that practical work provides. No longer will practical chemistry be seen by many students as a recipe-following exercise. AS Chemistry LabSkills supports the desire to impart the science behind the instructions in the practical scripts. Examination of this understanding is part of the requirements for the new A level specifications that were launched in September 2008. What this software is not is a simulation designed to replace practical work. What this is a piece of software to make better use of valuable practical time. By working through this interactive, computer-based work before coming to the lab, students are able to perform better and engage in the experiments in a very real way that allows teachers to spend their time proactively developing students' practical skills and reinforcing the theory behind the practical exercise.

The software is split into the two main parts of 'Techniques' and 'Experiments'. The techniques in this resource have been targeted at the first year of the two year A level course. Whilst the product was developed with the new UK specifications in mind the practical skills and the experiments are common to many post 16 chemistry courses. Table 1 lists the techniques supported. The 'Experiments' section takes the most commonly used practicals and gives an introduction, safety points, experimental procedure outlines and hints as to whether observations should be made. Additional features include a calculator, a periodic table and drop-down glossaries of equipment and reagents. The later were introduced at the request of students in trials of the software.

There are interactive simulations for setting up and optimising experiments within the software for the standard practical techniques. Figures 1-4 give a flavour of the simulations that allow students to develop their understanding of techniques in a safe environment that does not result in a big glassware replacement bill for practices that go wrong. Interactive videos (Fig 5) for each technique are included to further prepare students for the practical work ahead of them.

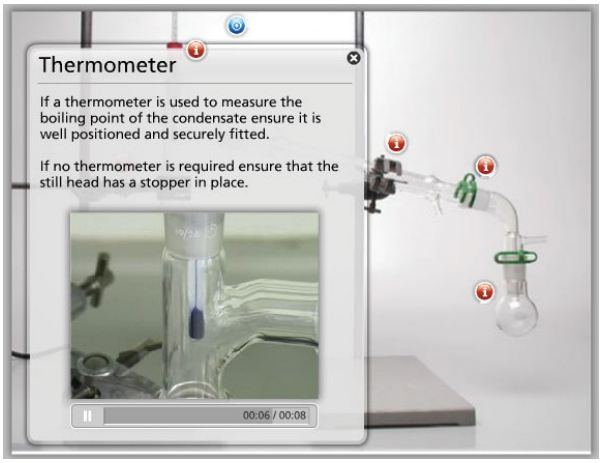

Figure 2 'Clickable' images explain safety and how to set up equipment correctly

There are 'test your understanding' quizzes for every topic covered the results of which can be printed or tracked electronically as a homework record. The print out gives the question, the correct answer and the answer the student have so is a valuable learning tool. When doing the test and getting a wrong answer the student is given feedback and pointed at the right answer. The resource is written for a typical range of Post 16 student abilities with some extension activities for more able students. Examination practice questions, complete with built-in hints and answer strategies, are spread throughout the resource.

An evaluation by David Brentnall, RSC School Teacher Fellow, Chemistry Teacher at Groby Community College, Leicestershire says *"Going from generic techniques to specific experiments is a powerful teaching strategy, allowing teachers to guide students through the use of techniques away from the lab ..... I can envisage having two or three laptops with the DLM up during lab sessions for support as required - enabling the teacher to be in two places at once! The quality of the presentation is very professional and I hope it will act as an encouragement to some staff that perhaps lack the confidence to carry out some of the more complex practical work at A-Level. I could see myself using it as a support tool with Newly Qualified Teachers or student teachers as well as students"*.

Lab techniques	Instrumental techniques	Basic skills
Reflux Distillation Recrystallisation Solvent extraction Filtration Melting point Titration Calorimetry - in solution Calorimetry - combustion Collection of a gas	Mass spectrometry IR spectroscopy **Tests and observations** Tests for inorganic ions Tests for organic functional groups	Weights and measures Preparing solutions **Lab calculations** Stoichiometry and yield Quantities and concentration Errors and significant figures

Table 1 A list of the Techniques section of AS Level LabSkills

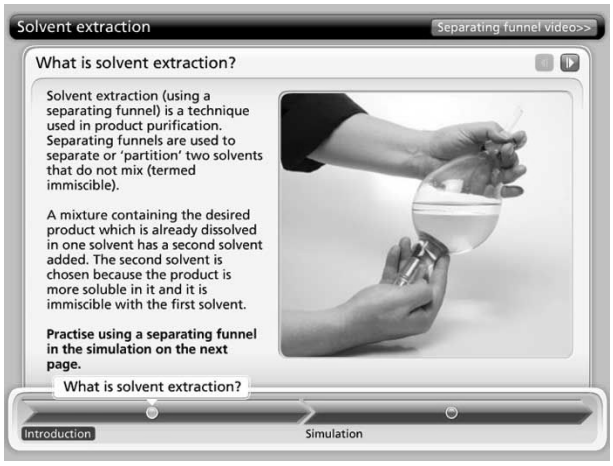

Figure 3 Teaching basic laboratory skills

The AS Chemistry LabSkills product is the result of collaboration between Bristol ChemLabS and Learning Science. Bristol ChemLabS is the project name for the Higher Education Funding Council for England (HEFCE) -funded Centre for Excellence in Teaching and Learning (CETL) in practical chemistry which is based in the School of Chemistry at the University of Bristol. Apart from the modern state-of-the-art, professional standard teaching laboratories the Bristol student's learning experience is greatly facilitated by the innovative web-based Dynamic Laboratory Manual (DLM) with its incorporated pre- and in-lab e-assessment. It is from the DLM that LabSkills sprouted.

The software for the second year of A level, 'A2 LabSkills', will be available at Easter 2009. International baccalaureate (IB) and Scottish Post 16 versions will also be available for the new academic year. Teachers, who wish to trial AS Chemistry LabSkills for themselves, or to look out for the other products, simply need to ask for a logon by through the website www.LabSkills.co.uk/index.php.

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Chemistry instructors in teaching laboratories provide expert modeling of techniques and cognitive processes and provide assistance to enrolled students that may be described as scaffolding...Â J Res Sci Teach 44(8):1160â€“1186CrossRefGoogle Scholar. LabSkills-a dynamic laboratory manual for students, schools, and universities (2010) Retrieved March 8, 2010, from http://www.chemlabs.bris.ac.uk/LabSkills.html. March JL, Moore JW, Jacobsen JJ (2000) ChemPages laboratory: abstract of special issue 24 on CD-ROM. J Chem Educ 77(3):423CrossRefGoogle Scholar. McKelvy G (2000) Preparing for the chemistry laboratory: an Internet presentation and assessment tool. Univ Chem Educ 4(2):46â€“49Google Scholar. The 21st century high school chemistry classroom provides a dynamic learning environment that is student centered and curriculum-driven. The floor plan is designed for conversation, collaboration, and discovery. The classroom should contain multiple spaces that provide for long-term multidisciplinary projects, individual and small group learning, inquiry lessons, project-based learning, and problem solving.Â The chemistry laboratory may contain moveable lab stations or fixed lab stations. The latter allows for a more productive use of time because the facility is always available.Â The Flinn Science Catalog Reference Manual (Flinn Scientific, 2011) and ScholAR Chemistry provide guidelines for proper disposal. Chemicals should be dated when received and opened.