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THE PRACTICE OF CHEMISTRY EDUCATION (REPORT)
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DESIGNING AND PRODUCING MULTIPLE LANGUAGE MULTIMEDIA COURSEWARE

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ABSTRACT: Multimedia courseware packages are considerably enhanced by the inclusion of moving images and animations. The cost of making such images is, however, very high. Rather than each group or country making its own images, i.e. "re-inventing the same wheel", it makes better economic sense to re-cycle existing images. The work of a dual language project team towards designing and producing multimedia resources in a number of languages is described. For example, the series of twenty dual-language CD-ROMs entitled "Le bon geste pratique en Chimie/Practical Laboratory Chemistry". The work opens up a wide range of possibilities for customizing resources from an "originating language" into any other language. [*Chem. Educ. Res. Pract.*: 2003, *4*, 77-82]

KEY WORDS: *multimedia; multiple language courseware; CD-ROMs; practical chemistry; software design*

INTRODUCTION

The ready availability of computers in schools, colleges, universities, the increasing ownership of computers by students and households, and the impact of the Internet signals that fundamental changes will occur in learning, teaching, and training in Chemistry in the 21st Century. For example, the use of multimedia technology. Since Chemistry is an intra-national subject with a broadly similar curriculum throughout the world, it makes good sense for practitioners to communicate their needs, share resources, exchange information about techniques, share best practices and collaborate in the design and production of new resources rather than each country "reinventing the same wheels". For example, the cost of the broadcast-quality images produced by the Chemistry Video Consortium (CVC) for the English language series of CD-ROMs, entitled "Practical Laboratory Chemistry", was £500,000 (ca 800,000 EURO). This equates to approximately £900 (1400 EURO) per minute of video (Brattan, Jevons, & Rest, 1999).

While it is clear that new multimedia resources will always be required to meet the needs of a rapidly evolving subject, it is also clear that many requirements could be met by recycling existing resources in other languages, subject to sympathetic copyright agreements and the means of locating suitable high quality resources, e.g. the “Chemistry Images” database maintained in the UK by the Chemistry Video Consortium (CVC; Southampton) and the Royal Society of Chemistry (Moss & Rest, 1997 & 1999).

A CASE STUDY

Teaching basic laboratory techniques to large enrolments of students is a challenging task. There are a number of problems which are difficult to overcome in ordinary teaching situations. For example:

- It is not easy to demonstrate precise operations to a group of students in such a way that each student can have a good view of all the details.
- It is sometimes difficult for students to watch a demonstration and at the same time understand and memorize all the significant steps.
- It is necessary to establish if the students have grasped the important points, especially in relation to safety matters.
- Students may need to refresh their memories by seeing specific parts of a demonstration during the course of a laboratory class.
- Demonstrators may not always be available to repeat the demonstration several times or give further explanation when required by the students.
- In some cases, demonstrators may not be fully motivated and trained to perform a specific demonstration.

Although it is clear that acquiring practical skills cannot simply be achieved by watching demonstrations but requires hands-on work in the laboratory, the importance of giving precise instructions and showing good laboratory practice cannot be denied. For this purpose, the use of audiovisual resources can be of great help.

Arising out a SOCRATES Open and Distance Learning Project on “Multimedia Resources for Chemistry in Europe” (Oskam & Rest, 1999), the CVC and the CDIEC are collaborating to produce a series of dual language interactive CD-ROMs based on the “Practical Laboratory Chemistry” series (1999). The new series was published in 2002 (Cabrol-Bass, Rabine, & Rest, A.J., 2002). This collection is made up of eighty units covering most of the basic techniques in use in teaching laboratory at the tertiary level (see Appendix). The list of topics was compiled by collecting the “Top 80” basic techniques as they appear in the laboratory manuals in use in Chemistry Departments of UK universities.

In addition to customizing for different languages, customization can occur for different levels. For Example the CVC has collaborated with the Royal Society of Chemistry to produce 2 CD-ROMs for instructing students in the age range 16-18 (pre-university). This series, entitled “Practical Chemistry for Schools and Colleges” (Jevons, Lister, & Rest, 2000) has been distributed to all the relevant institutions in the UK (ca. 4,000) via sponsorship by *ICI* and *Sigma Aldrich*. Feedback from the schools and colleges has been so positive that the Royal Society is currently engaged on a program of customizing other resources into multimedia format for students in schools and colleges.

TECHNICAL DETAILS

Each unit comprises a video sequence of high quality lasting between 5 to 10 minutes with a voice-over commentary, a Glossary and a Quiz which can be used by the student for self-assessment. Topics can be used by laboratory staff for pre-laboratory instruction. The Macromedia Flash interface gives the user complete control of the following elements:

Contents
- Choice of the Unit by topic
- Choice of a section within a Unit

Display
- Sound On or Off
- Choice of the language for the spoken commentary (e.g. English/French)
- Display of the commentary as subtitles (c.f. "Karaoke")
- Choice of the language for the written materials (e.g. English/French)
- Size of the video image

Sequence progress
- Start
- Stop
- Direct access
- Repeat Unit
- Repeat the last sentence

Learning activity
- Watch the video sequence
- Consult the Glossary
- Self-assessment using the Quiz

The software shell, which was written in Visual Basic, has been specially developed for this project and makes use of external files. The video file (in MPEG format) is unique since it does not contains linguistic elements. The sound files and text files of the commentaries (or voice-overs) as well as the Quiz files (in TXT format) are language dependent. Therefore there is one of each of these files for each language.

The user interface is written as Macromedia Flash and sends all users choices and actions to the shell as specific commands. In turn, the shell sends commands to the Windows Mediaplayer 7 for a smooth control of the video and sound files.

Development of a new version for another language will involve the following steps:

1. Translating the commentaries into the target language.
2. Editing the commentary text file in RTF format.
3. Recording the voice over of the commentaries.
4. Synchronizing the sound file, in JPEG format, using the time tags associated with the video file.
5. Indexing the text file, for each time tag and each sentence.
6. Translating and adapting the quizzes to the target language.
7. Editing the quiz files in TXT format.
8. Modifying the user interface in Flash 5 for its language dependent content.
9. Translating the Glossary into the target language.

Currently, the last step is the only one for which the linguistic content is hard coded (using Flash 5).

FUTURE DEVELOPMENTS

Work is in progress to develop software that will use external text files for the Glossary in order to allow its adaptation and expansion by teachers without the need for programming.

The procedures described above can be applied to customizing any combination of resources from a wide variety of national and international sources into multimedia packages which can be specific to a course unit in any language or combination of languages. For example, a multiple languages demonstration CD-ROM comprising at least six languages with one non-Romanesque language, e.g. Russian, has been completed in 2002.

CONCLUSION

The work described above indicates that a breakthrough has been achieved in the use of images in multiple language multimedia courseware and in customizing resources from one language to another. The work also provides a model which can save substantial amounts time and expenditure on the part of staff, institutions, and countries and is applicable across all the natural, physical, engineering and life sciences.

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APPENDIX: LIST OF PRACTICAL LABORATORY UNITS/TOPICS

1. *Basic laboratory techniques*
Assembling apparatus
Using Stirrers
Measuring and controlling temperatures
Heating Samples
Using a Rotary Evaporator
Refluxing

2. *Weighing and volumetric techniques*
Using balances, material transfer
Using a pipette
Using burettes
Making up solutions

3. *Distillation techniques*
Atmospheric pressure distillation
Reduced pressure distillation
Fractional distillation
Steam distillation
Semi micro distillation

4. *Purification techniques*
Atmospheric filtration
Appendix : Folding filter papers
Reduced pressure filtration
Recrystallisation
Appendix : Tests and precipitation
Sublimation

5. *Extraction techniques*
Solvent extraction
Appendix: Dealing with emulsions
Soxhlet extraction
Continuous flow extraction
Drying samples

6. *Microscale basic laboratory techniques*
Assembling microscale apparatus
Weighing and material transfer
Heating samples

7. *Microscale purification and separation techniques*
Atmospheric filtration
Reduced pressure filtration
Extraction and separation
Atmospheric pressure distillation
Distillation of high boiling point liquids
Recrystallisation
Craig tube recrystallisation
Using Grignard reagents

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8. *Microscale characterisation techniques*
Thin layer chromatography (micro)
Column chromatography (micro)
Gas chromatography
Determination of boiling temperature
Determination of melting temperature
Appendix : Hot stage microscope
Infrared spectroscopy of solids
Infrared spectroscopy of liquids

9. *Chromatographic Techniques*
Thin layer chromatography
Column chromatography
Ion exchange chromatography
Gas phase chromatography

10. *Gravimetry and Nitrogen determination*
Gravimetric analysis
Electrogravimetric analysis
Kjeldahl determination of nitrogen

11. *Volumetry – Potentiometry - Conductimetry*
Volumetric titrations
Some common end points of indicators
Potentiometic titrations
Introduction
pH titration
Potentiometric titration : oxidation/reduction
Potentiometric titration of halogen ions
Conductimetric titration
Appendix : Using conductimetric cells
Using an Automatic Titrator

12. *Changes of state with temperature*
Determination of melting temperature
Appendix : Preparing melting tubes
Appendix: Hot stage microscope
Determination of boiling temperature

13. *Optical methods*
Using a polarimeter
Determining the refractive indices of liquids
Flame photometry

14. *Spectroscopic methods*
Infrared spectroscopy of solids
Infrared spectroscopy of liquids
Infrared spectroscopy of gases
Appendix : Filling an infrared gas cell
UV - Visible Spectroscopy
Appendix: Relationship of UV spectra with molecular structure
Colorimetric analysis
Preparing samples for NMR spectroscopy
Measuring gas phase emission spectra
Using atomic absorption spectrometer

15. *Other methods*
Measuring radioactive activity
Atomic absorption spectroscopy
Thermogravimetric analysis
Determining the molecular weights of gases

16. *Radiochemistry*
Measuring radioactive activity

17. *Thermochemistry*
Using a bomb calorimeter.
Using a Dewar calorimeter
Determining enthalpies of neutralisation
Thermogravimetric analysis

18.*Phase* and *Chemical equilibria*
Measuring boiling temperature pressure dependence
Appendix : Using a Fortin barometer
Measuring the NO_2/NO_4 equilibrium
Determination of liquid/liquid phase equilibrium
Determination of solid/liquid phase equilibria
Measuring partition equilibrium coefficients

19. *Electrochemistry*
Using Galvanic cells
Determining standard electrode potential
Determining solubility products
Determination of thermodynamic characteristics of cells
Chemical kinetics
Oxidation of iodides by H_2O_2
Oxidation of iodides by $K_2S_2O_8$
Iodination of ketones

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