

Interactive Virtual Chemical Laboratory

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Abstract

The co-operating partners are developing within the framework of the project »ICT in learning and teaching chemistry« an interactive virtual chemical laboratory. The laboratory is intended to motivate students for learning chemistry in a different and attractive environment, thus enabling them to understand better the correlation between macroscopic observations of experimental results and their explanations by using the theory of the particulate nature of matter. For the teachers, the laboratory will represent an additional teaching tool, which will supplement their explanations and develop the pupils' and students' information literacy. In the interactive virtual laboratory, the users will have an opportunity to select content and experiments according to their interests and capabilities. They will test the understating of the selected experiment; get acquainted with chemical hazards, and have a possibility to study the safety measures in handling chemical reagents. At the higher level they will observe the animations of the experiments at the sub-microscopic level and correlate the results with theoretical

background. With the help of interactive test items they will upgrade and broaden their knowledge.

Key words: interactive virtual chemical laboratory, experiments, and animations.

Introduction

MacFarlen (1998) in his analysis of correlation between information, knowledge and learning stresses the importance of the role of lifelong learning in the information-based society. Lifelong learning takes place at the workplace and at home and its quality depends to a great extent on the use of information communication technology. Therefore, according to Wilson (2001), the basic precondition for a qualitative life-long learning is well-developed information literacy, which is a skill common to all disciplines and educational environments. Education institutions must adopt new trends in designing their educational programmes.

As a joint project between Faculty of Science and Engineering, Faculty of Computer and Information Science, Faculty of Chemistry

and Chemical Technology and University College of Health Care a novel Interactive Virtual Chemical Laboratory (IVCL) has been developed. It can be regarded as a new multimedia educational tool for teachers and students. It enables the introduction of new teaching strategies and supports the development of higher skill levels: communication and information literacy, independent knowledge management, problem solving, individual and collaborative learning, etc.

Scenarios

In the initial project phase, multiple activities were designed and were then interlinked with the interactive chemistry laboratory. The main activity is learning chemical concepts and processes on the macroscopic, sub-microscopic and symbolic levels. Other activities are: discovering the properties of reagents and product of chemical reactions, using the database, learning chemical software for drawing 2D and 3D chemical structures, and knowledge testing.

IVCL was developed in multiple steps. First, the content, corresponding the chemistry curriculum for primary and secondary schools was selected on the criteria of suitability for multimedia presentation, and applicability to everyday situations. The topic selected was "Particles and Reactivity", in

which the main concepts presented were: diffusion in comparison with solvation and precipitation, differences between the reactions occurring among ions in a water solution and among molecules in gaseous or dissolved state.

Production and technologies

The next step was designing experiments for visualisation of selected chemical concepts and processes on the macroscopic level. Different versions of video with experiments were made with a digital camera. Several considerations had to be taken into account: angle, lighting, contrast, hand movement, effectiveness of the experiment (quantity of reagents used to achieve maximal visual change). Best videos were selected and then processed with Adobe Premiere 6.0. Sound (narration), subtitles, pointers, symbols and pictures were added to support the understanding of experiments. Visual information on the hazards of the reagents was also incorporated in the clip.

In parallel, scenarios for the animation of the experiments on the particle level were prepared. For each scenario we had to define the properties of particles (i.e. shape, relative and absolute size, relative and absolute speed at the reaction temperature). The main part of the scenario was divided into a series of scenes. For each scene we had to define the

number of particles, their movement in the virtual space, types of collisions, change in size and shape of particles after collision. The organization of particles in a crystal lattice, when the reagents or products of the reaction were in solid state, had to be described. The connection between the macroscopic and sub-microscopic world was achieved by including short clips of the experiment, using the zoom effect. In the following step molecular models (molecules, ions and crystal structures) were prepared with the 3D modelling software (Spartan, ChemSketch, MoluCad).

The next step was animation and choosing between modern technologies that offer many options how to make a 3D animation. We wished our animation to be interactive. We also wanted to avoid problems with hardware, software compatibility and portability between different operating systems. At the end we decided on Maya software, which can be used for modelling and animation. The limitation of the selected software is that it does not allow interactivity, but the film we created can be used in different systems. With Maya we made short animated films, which we later combined with sound, subtitles, pictures and other elements to create the final version of film. The database on substances with the information on physical and chemical

properties, environmental and medical impact and visual and structural representations of substances was created.

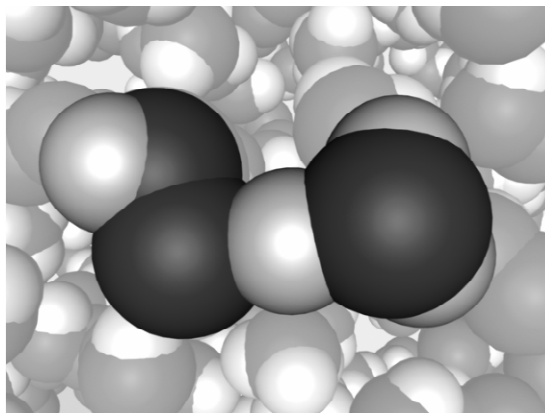


Fig. 1: Snapshot from animated chemical reaction

Following video production, the animations and the database had to be prepared, various types of interactive exercises, aimed at testing the understanding of the macro and sub-microscopic change, were developed. The user needs to associate the results of the experiment with the particle nature of matter, thus developing skills for information retrieval (database). Explanations and correct solutions are provided for every exercise.

Virtual laboratory on Web

In the final phase the online portal of the Virtual interactive chemistry laboratory was set up. Interactive representations of chemical structures and videos require specific freely available plug-in software. To

reach the broadest spectrum of users, both the English and Slovenian version were created. The web address of the laboratory is <http://www.ntfkii.uni-lj.si/crp2-eng/frame.htm> and <http://www.ntfkii.uni-lj.si/crp2-slo/frame.htm>

The content of the virtual laboratory can be accessed from different entry points: experiments (micro/sub-micro level), media elements (videos, animations, 3D molecular models, images), interactive exercises, reagent/product database.

The laboratory is intended to teach students about chemical reactions and processes on three different levels of explanation: macroscopic, sub-microscopic and the symbolic level. For the teachers, the laboratory represents an additional teaching tool, supplementing their explanations and at the same time developing students' information literacy. The use of the laboratory encourages logical thinking, by correlating the conclusions made from observation with the theoretical background.

References

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