

AN ORGANIC CHEMISTRY CD-ROM AS A MULTI-USE TOOL FOR LEARNING OR TEACHING

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ABSTRACT

This CD-ROM, used by undergraduate first year students in the science faculty, is composed of two sections: the schemes, drawings and animations used in the course on one hand and interactive exercises on the other hand. The conception of this CD ROM allows the student to use it as a revising, visualisation and learning tool, but also as an evaluation tool. On the other hand, from the teacher point of view, the use of the CD-ROM allows some feedback about the teaching method and may be a tool for improving the teaching. Finally, the CD-ROM may also be used in a "teaching mode", like a powerpoint presentation.

KEYWORDS:

Organic chemistry- undergraduate students - learning - visualisation - evaluation - teaching

INTRODUCTION

The tool has been designed in order to compensate for some of the difficulties frequently encountered among first year students. Among other difficulties: students enter the University with a large diversity of levels and it is laborious to drive this very heterogeneous public to a common and acceptable level. Experimental tools are lacking for making chemistry demonstrations in large groups auditoriums and it is difficult to sustain the student attention during rather long lectures. Students have very often difficulties in visualising phenomena in a 3 D space and to understand that chemical mechanisms are dynamical phenomena.

During his learning and if an appropriate tool is not given to the student facing exercises, two opposite situations may be encountered. In the first one, the answer to an exercise is given without comments and this does not help the student to improve his reasoning. In the second one, the reasoning is fully described and the student may limit his involvement in a passive reading of the demonstration without trying to learn by himself.

This CD-ROM, used by more than 400 undergraduate first year students in the science faculty of UCL university (Louvain-la-Neuve, Belgium), has been designed using the Director and 3DSMax softwares. It is composed of two sections. In the first one, the schemes and drawings together with the animations used during the course are given on one hand. In the second one interactive exercises (more than 200) are presented and arranged according to the outline and progress of the course. Due to its organisation, this CD ROM may be viewed as a multi use tool for the student but also for the teacher.

REVISING TOOL

When entering into the program, the student is allowed to choose the course or exercise section. The course section may be viewed by the sequential method as used during the lectures or by direct access to a particular information or theme by the way of a general index. Whatever the topic present on the screen, (course or exercises) the general index is always available. If the student does not know how to

consult the index, a keyword button, active in the course section, gives him access to a list of keywords related to the active screen and allows him to easily enter the index. From the index he can be sent back to other sections of the course related to the same topic. From any point in the program, a direct return to the list of content (of the chapter or of the course) is accessible (see figure 1).

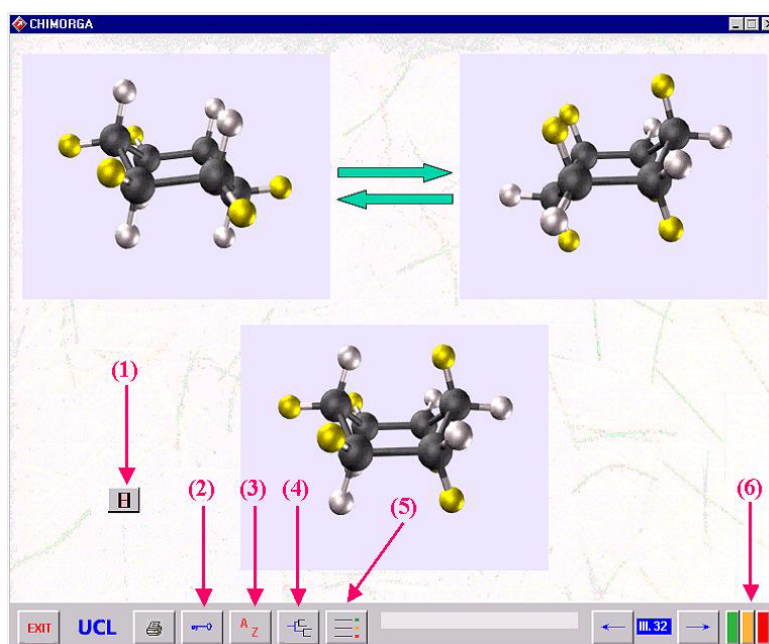


Figure 1. Screen sample of the course section

(1) Access to the animation, (2) Access to a keywords list, (3) Access to the index, (4) Access to the table of contents, (5) Access to the evaluation marks, (6) Activators of the coloured flags.

VISUALISATION TOOL

More than 70 animations, showing molecular models or reaction mechanisms in a dynamic way, were realized and are accessible, from the relevant screens in the course section, by the simple activation of a button (see figure 1).

The animations, realized with the Studio 3D Max software, make it possible to visualize frame by frame, or in a continuous way the mechanism or the explained concept (Figure 2).

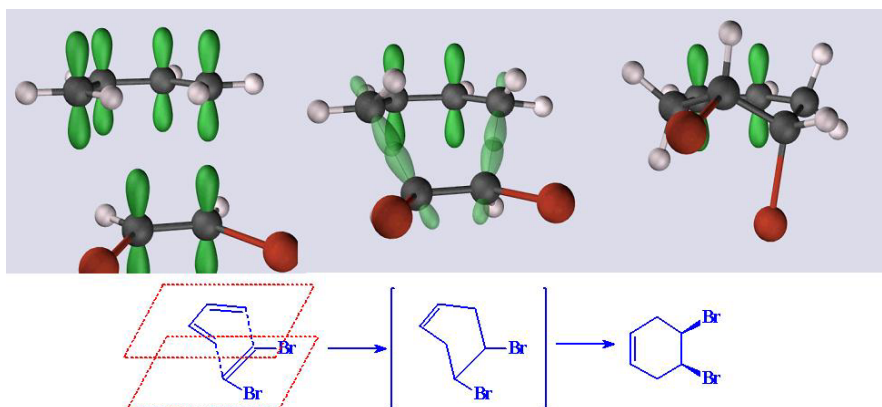


Figure 2. Animation pictures in Diels Alder cycloaddition mechanism

Stereochemistry, molecular conformations, reaction mechanisms and orbitals visualizations are among the treated topics.

LEARNING TOOL

More than 200 interactive exercises are available. Multiple choice questions are sometimes used but the presentation mostly moves away from this method and questions are presented in various ways. Students are asked to complete tables of properties with elements, given on the screen, in tool boxes. Lists of formulas and of properties are given in a random order and are to be associated in the appropriate order. Tool boxes containing formula or reaction elements (bonds, charges, electron pairs, arrows, chemical groups, reactants, etc...) are to be used for completing, on the screen, formulas, reaction schemes or multistep reactions. Questions leading to numerical answers or with a true or false answering are also used. In each case, the exercises are designed in such a way that the answer is not immediately evident. The student is stimulated not to solve the exercise by a succession of fruitless attempts and the content of toolboxes are composed in such a way that the student has choices to make in order to make a selection among a set of useful and useless elements.

Help to the resolution is always given in such a way that the student may verify which part of his answer is not correct. After having completed a tentative answer, the student may ask for the result of his work (see figure 3).

ChimOrgav4beta2

Exercice 4 Marquez de l'astérisque bleu les carbones asymétriques des molécules ci-dessous. Indiquez dans la case le nombre de stéréoisomères possibles pour chaque molécule.

(3) → 4

HOOC-CH₂-CH*(CH₃)-CH₂-CH*(CH₃)-CH₂-COOH

3

32

16

1

2

Résultat

EXIT UCL Ex VI.4

Figure 3. Stereochemistry exercise

- (1) Asterisk from the toolbox has been dragged in different positions of the formulas, (2) Access to the correction of the exercise may be asked, (3) Numerical answers have been given.

In case of wrong or incomplete answer, a red light is switched on and the student may take a triple choice: going back to work and trying again, getting help by showing what is wrong or showing the final result (see figure 4).

The exercises are presented chapter by chapter but as a revising tool, the student can ask to get exercises in a random way.

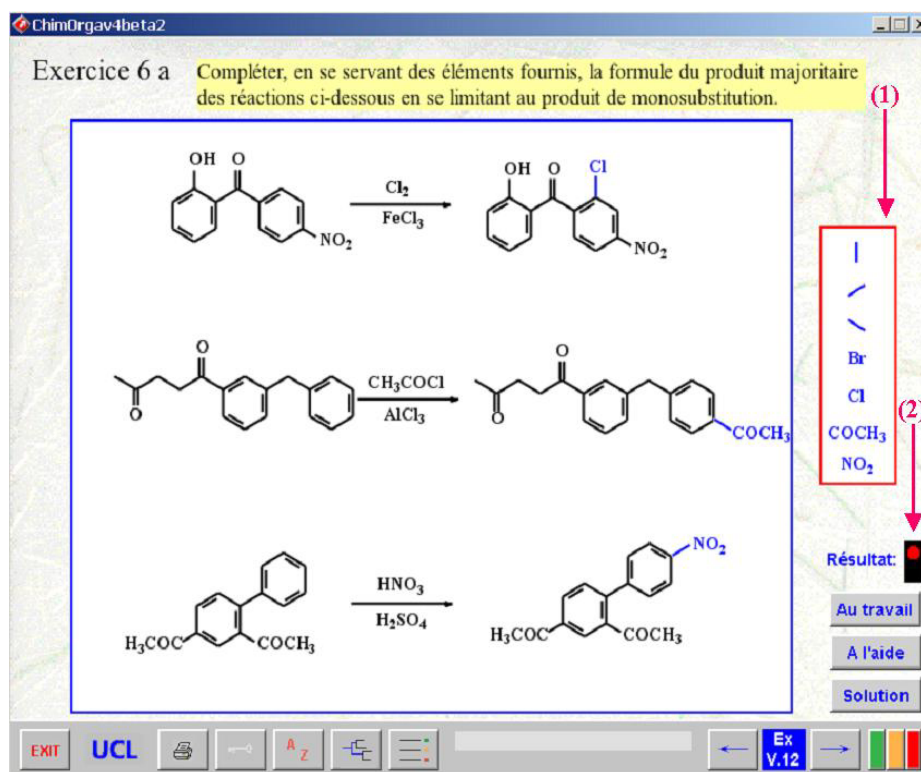


Figure 4. Exercise on organic reactions

(1) Elements of the toolbox have been dragged to the reaction scheme. (2) The answer is wrong and the red light is switched on: buttons corresponding to the three choices given to the students are present.

SELF-EVALUATION TOOL

The student is allowed to mark each CD frame (course or exercise) using a coloured tag (see figure 1) in accordance with the acquired knowledge or skill. The whole set of tags, which can be visualized at any moment (see figure 1) is the trace of the progress of his learning. This information can be stored in a file, enabling the student to evaluate his work from period to period. Students are working with this program at home or on workstations at the UCL university and they have the possibility to keep their information on a UCL server.

TEACHING TOOL

This CD-ROM may be used in a "teaching mode", like a powerpoint presentation, with objects appearing in a predetermined sequence. When the CD ROM is activated in this mode, the teacher is allowed to underline or circle data by directly writing on the screen.

Besides of this teaching advantage, interactions with the students may help to improve the teaching method since, during the semester, the student will be invited to download his file to a server of the faculty. The data collected in this way, may be treated statistically in order to observe, from the teacher point of view, what is the mean progress of the students group and this is a useful feedback for teaching improvements. Histograms of their performances may be constructed [*]. The exercises giving rise to large difficulties may be evidenced showing that, during the course, some supplementary effort is to be done for explaining the corresponding topics.

EVALUATION OF THE CD ROM

The CD ROM has been introduced as a learning aid at the beginning of the 2001-2002 academic year. At the beginning of the following academic year an evaluation has been performed among 150 students. The CD ROM was considered useful and easy to use by more than 90% of the students. The availability of the 3D animated mechanisms and of the exercises section was highly appreciated by more than 75% of them. All the users underlined that their 3D perception was clearly facilitated by the use of the animations. The enthusiasm of the students was somewhat lower (only 60%) when considering the coloured pointers, index and keyword systems. When asking them which fraction of the CD ROM had really been used, the mean values were 65% for the exercise section and 20% for the theory.

As far as the examination results were considered, no clear conclusions can be drawn since the CD-ROM is only a part of the multiple tools (printed syllabi about theory, exercise book and molecular models) given to the students and it was not possible to introduce this new tool selectively to several students only.

On the other hand, it was very difficult to convince the students to download their learning progress file to the faculty server: a rather low participation (less than 20%) to the data collection has been recorded.

The use of the CD ROM by other professors has not yet been tested and attitudinal resistance may be expected in this field. However, this corresponds to the traditional cleavage between professors unconditionally defending a "blackboard" teaching and others favouring more the possible progresses gained through the use of the multimedia methods. Here again, the availability of the 3D animations is unanimously considered in a positive way.

CONCLUSIONS

After a one year use of the CD ROM, it clearly appears that the availability of 3D animations and of interacting exercises are the most important benefits underlined by the students. The availability of the theory documents is of course less crucial for them since they also received paper copies of these documents.

As far as the teaching aspects of the CD ROM are considered methods will need to be found in order to motivate the students for sending their data to the faculty server thus allowing a good statistical evaluation of their learning progress.

ACKNOWLEDGMENTS

The financial support of the "Fonds de développement pédagogique" of the UCL University, is gratefully acknowledged.

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