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Of Special Interest

A Review of Corel's ChemLab CD-ROM

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I think this is the beginning of a new generation of laboratory simulation software.

Chemistry laboratory simulators have not been worth consideration until the CD-ROM came along with its wonderful capacities. Corel, [1] a well-known name in software has realized this. Their new *ChemLab* CD-ROM has excited some interest among chemistry teachers. This review examines the contents of this CD-ROM, rates the effectiveness of its "experiments," and suggests who might profit from the use of such a simulator for the traditional chemistry laboratory.

Historically the computer simulation of a chemistry laboratory workbench has been a crude, even laughable, thing. Now, with the capabilities of CD-ROM, the appearance of this simulation is neither crude nor laughable.

Corel, with the help of Ebbing's *General Chemistry* [2] and some videos licensed from *JCE: Software*, has produced a chemistry laboratory simulation that is both entertaining and

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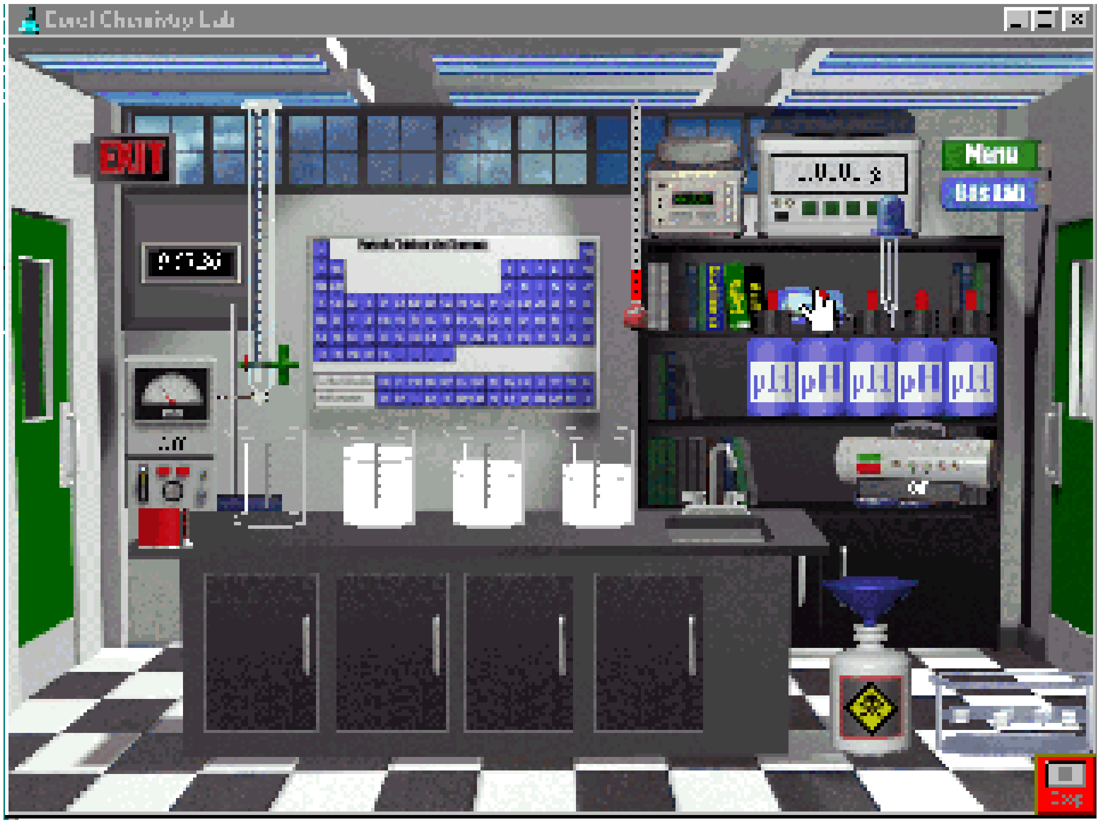

FIGURE 1. OPENING SCENE FROM COREL'S CHEMLAB.

useful. But let us begin at the beginning—the opening scene (Figure 1) when you run this CD-ROM.[1] ChemLab opens with a laboratory bench, on top of which are four rather large beakers; three contain something. Around the laboratory are various instruments and books; a hazardous-waste bottle and an ice bath are on the floor. Moving the cursor over an object identifies it, so you quickly discover that the contents of the beakers are 100.00 mL of H_2O, 75.00 mL of CH3COOH, and 70.00 mL of 0.1000 M HCl. A complete list of the instruments is available in the file, 21rc1897.pdf (11.9 Kbytes).

Like most of my students, it is certainly not my inclination to read the directions, so I began trying to measure things in the laboratory. After turning off the infernal music, I found a thermometer, so I measured the temperature of everything I could find. It read

[1] Two self-contained animations of the laboratory are available to IBM PC compatible users by downloading the files opening.exe (2,564 Kbytes) and altopen.exe (2,472 Kbytes). After downloading the files, just double-click on the program to begin the animation sequence.

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20.0 °C for everything except the ice bath. When I tried to measure the temperature of the ice bath, the thermometer dropped, there was a crashing sound, and it disappeared. The only way to get it back was to do a reset (ctrl r) and begin over. The same thing was true of the beakers. If you dropped one, a crash and reset were in order. Happily, the broken glass and spilled mercury were not simulated.

I found that I could not move the pH meter to the solutions, so I moved the solutions to the pH meter. When I did, the solution sprang back onto the bench top, now connected to the pH meter with a red line, presumably the probe. The pH meter indicated that the hydrochloric acid solution's pH was 1.0000, the pH of the acetic acid was 2.8876, and that the pH of the water was 7.0001. Ah, if I only had such an accurate and reliable pH meter in my real laboratory!

I poured some HCl into the empty beaker, added a few drops of phenolphthalein off the shelf, and titrated it with the NaOH solution (found conveniently already in the burette). It was quite realistic. The solution turned pink at the proper point in the titration. I was impressed, so impressed in fact that I decided to read the directions and do an experiment properly.

There are five groups of experiments. Eight are physical-property experiments, 12 are acid–base experiments, four are kinetics experiments, five are gas law experiments, and three are "additional experiments." One of the latter is a redox titration; the other two are radioactivity experiments. A complete list of the experiments is available in the file, 21rc2897.pdf (14.1 Kbytes).

I was impressed with the experiments. These, of course, always work. The starch indicator never goes bad, and the open solutions never absorb carbon dioxide from the air. It is possible that if a student did them all carefully, the learning of chemical theory might be as great, or maybe even greater than, as after doing real experiments. The student would not, however, be proficient in a real laboratory after these. In this cyberlab the laboratory instantly cleans itself up when you choose to begin a new experiment. In real laboratories, no magic cursor analyzes your solutions for you, and measuring volumes of solutions is a much trickier operation.

Perhaps I should mention that the user has a choice of four "themes" when the program begins. If you looked at the opening scene earlier in this review, you were in the "contemporary theme." Other choices are the "dungeon_theme.tif," the

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"futuristic_theme.tif," and the "tropical_theme.tif" (301 Kbytes each). Why these choices are there I have no idea. I can only presume that this portion of the programming was done by former game programmers who couldn't help themselves.

The CD has additional features beyond the laboratory experiments. There is a periodic chart with some limited information about the elements in it. There are short videos showing some standard demonstrations. A complete list of the videos is available in the file, 21rc3897.pdf (11.5 Kbytes). I could not help but ask myself, are these videos more "real" than the simulated experiments? I do not know the answer.

There is a "molecule viewer" showing ball-and-stick models of 164 molecules. These models can be rotated so as to view them from any angle. This is nice, I suppose, but in my opinion simply promotes the fallacy we all encourage, namely that "H_2O is water." I prefer "H_2O is a crude representation of the imaginary entities we use to explain some of water's properties." Pictures of balls and sticks may help some student's visualization processes, but these are not molecules.

There are several acids and bases available for titration with one another. A complete list of the acids and bases is available in the file, 21rc4897.pdf (4.20 Kbytes). Their starting concentration can be chosen in 0.01-M increments from 0.1000 to 0.2000 M. An amazing feature that students may love, but instructors may hate, is the self-plotting titration graphs. These create themselves as the titration progresses, and can then be copied to the Windows clipboard for inclusion in laboratory "reports." Now students may never learn to construct graphs themselves.[2] Oh well.

The entire text of Ebbing's *General Chemistry* [2] is just a few mouse clicks away. I didn't use this feature. I wonder if anyone would?

After working with this software, I asked myself which students or which instructors might be most likely to benefit from the use of this software. My answer is that high school instructors would benefit most. The software is a great review of what they should already know, and many features could be useful as TV demonstrations in those high schools where virtually no laboratory apparatus is available. College-level

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[2] A self-contained animation of the titration experiment is available to IBM PC compatible users by downloading the file titrate.exe (2,912 Kbytes). After downloading the file, just double-click on the program to begin the animation sequence.

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teaching assistants could benefit for the same reasons, particularly if they are assigned to guide a real laboratory in which a similar experiment is to be done. College students taking a real laboratory course would not have time for this simulation, and certainly will be better served by real experiments, even if they don't always work, than by these idealizations. College level instructors may find the software intriguing, and briefly cute, but there is not much here that isn't better illustrated by reality.

This software is probably the beginning of something. The ability to go beyond pre-chosen experimental directions and invoke concentrations and temperatures of your own choosing are certainly breakthroughs in constructing a useful laboratory simulator. This is version 1.0. If Corel continues this project, I have a few suggestions:

Measure out volumes of the solutions with a simulated pipette, rather than the counting drops method.

Try to find something besides mercury for the simulated heating in an open beaker. The thought of a student actually trying this is scary.

Make the student clean up the laboratory before starting the next experiment. I do.

Spell vaporization either with the American spelling or with the English vapourization, but not both.

Mysteriously, the fire extinguisher is left out of one of the "tropical theme." Not that it does anything, but locating it is part of the safety list.

In conclusion, I don't regret buying this CD-ROM. I think this is the beginning of a new generation of laboratory simulation software. It is not to be preferred over actual experimentation, of course, but it can be programmed with an astounding amount of detail. I do not discount the instructional value here. I eagerly await version 2.

REFERENCES

1. ChemLab is available from; Corel Corporation, 1600 Carling Avenue, Ottawa Ontario, Canada, K12 8R7, (613) 728-8200, FAX (613) 9790. Approximately $60 retail where CD-ROMs are sold. Not available in Macintosh format.

2. Ebbing, D. *General Chemistry*, 5 ed.; Houghton-Mifflin: St. Charles, 1996.