Virtual laboratories in (bio)chemical engineering education

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Information and Communications Technology (ICT) has largely reconfigured the learning panorama over the last decade. The Internet paves for the creation and adoption of new learning and teaching styles. It facilitates the development of additional teaching strategies, including new ways to use them for illustration, simulation, demonstration, experimentation, operation, communication, and so on.

Hands-on laboratory experiments have enormous educational value, but traditional teaching laboratories are expensive and have complex logistics regarding space, staff, scheduling and safety (Selmer et al., 2007). Virtual laboratories (virtual labs) may overcome these limitations allowing the insertion of laboratory experiments in teaching at any time and the experiments can be performed from any place with internet access (Ferreira, 2004). Even though virtual labs cannot substitute hands-on laboratory experiments completely in the engineering curriculums, it has several advantages as a complementary educational tool.

The Universidade do Minho is being promoting a pilot project for development of components and software agents for assistance in laboratory lessons of curricular units from Science and Technology areas. These software contents will lead to the establishment of virtual laboratories and its offer via Internet will allow a better preparation of the students as well as e-Learning education activities. The portal http://vlabs.uminho.pt/ gives access to virtual laboratories where animations, videos and remote control of experiments can be handled, giving extra digital content for teaching in laboratory classes and for curricular units without laboratory schedule assigned. Contents and didactic material are being developed for virtual laboratories where the student can enter to know and explore objects like microscopes, reactors and "manipulate" intangibles realities like understanding how a molecule can catalyze a modification in another one.

Biological Engineering Department is engaged in this VLabs Project. The launching of virtual laboratories, with the insertion of these tools in teaching activities and his offer in internet, will permit the preparation of the students before having the laboratory classes or the examination, simulation or observation of certain key-experiments to understand the material for those curricular unities.

This paper describes the design and implementation of two virtual labs for biochemical engineering education. These virtual labs were designed for the course “Chemical Technology Laboratory” taught in the third year of Biological Engineering integrated Master studies. The first experiment was used by students in 2006. The effectiveness of the implemented system was evaluated through direct experimentation and survey (through questionnaires) with students taking the chemical technology lab course and these results will also be discussed.

One of the virtual labs is the determination of the correlation between oxygen transfer rate (kLa), aeration rate and agitation power. The designed web platform is presented in Figure 1. The main menu has five different areas: theory fundamentals, experimental

methodology, calculation methodology, references and laboratory where the students can do the virtual experiment. This virtual lab replaces the hands-on experiment. The advantages over performing the experience are clear: reduced costs, reduced experience time, improved data with no loss of education efficiency. The other virtual lab is the determination of the residence time distribution (RTD) in continuous tank series and was implemented to support the experiment and not to replace it. In Figure 1 a screen of this virtual lab is also illustrated. It is divided in three main areas: theory fundamentals, experiment and simulation. With this virtual lab it is shown that the internet can also support the traditional hands-on laboratory experiments by providing the student with an experiment platform consisting of the theory underlying the experiment, pre-visualization of the experiment (videos, simulation) and generation of data. This web support will improve the student effectiveness and autonomy in the laboratory class, in result analysis and report writing.

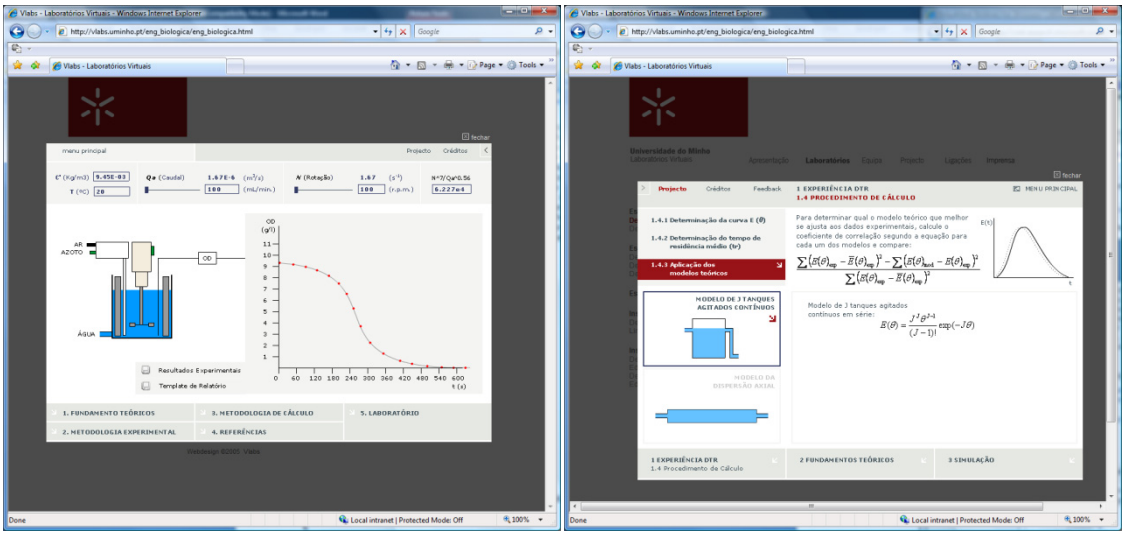

Figure 1. RTD and Aeration/Agitation Virtual Labs.

The educational value offered by virtual labs can be gained in different ways and this is demonstrated by the two implemented virtual labs.

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References

Ferreira, E.C. Blended Learning in Bioprocess Systems Engineering Education: Issues, Methods, and Applications. ESCAPE-14: European Symposium on Computer Aided Process Engineering. Lisboa, 16-19 Maio, 6 pp., 2004.

Selmer, A., Kraft, M., Moros, R., Colton, C.K. Weblabs in Chemical Engineering Education. Trans. IChemE, Part D, Education for Chemical Engineers, 2007, 2: 38-45.